5.4 INDICATOR CONTAMINANTS IN SURFACE WATER

This section summarizes the surface water data collected during the RI investigation. These data include those collected between November 2004 and March 2007. The surface water study was designed to characterize surface water contaminant concentrations and flow conditions of the river during three different flow regimes: low river flow (low flow; <50,000 cfs), high river flow (high flow; >50,000 cfs), and storm water-influenced flow (low flow conditions with active runoff in the Study Area). The threshold discharge rate of 50,000 cfs was selected because it is the river discharge at which significant transport of streambed sediment begins (Willamette Basin Task Force 1969). The geographic locations of all surface water sampling locations are presented on Map 2.1-18.

The discussion of indicator contaminants addressed in this section focuses primarily on the following elements:

- A description of the data set for each contaminant;
- The relationship of contaminant concentration with respect to flow rate;
- The sampling locations and event types with elevated contaminant concentrations compared to ambient water quality criteria (AWQC); and
- Locations with the highest contaminant concentrations.

The following subsections present tables and other graphical formats to support discussion and evaluation of the in-river distribution of the 14 indicator contaminants discussed in the RI main report. Additional tabular and graphical summaries of additional 21 contaminants in surface water are included in Appendix D3.

The final subsection in this discussion presents a site-specific evaluation of hydrophobic contaminants using four contaminants: PCBs, Dioxin/Furans, PAHs, and DDx. This discussion presents the relationship of contaminant concentration with respect to dissolved and particulate fractions and relationship with suspended solids and associated organic carbon.

The surface water chemistry distributions and supporting information are depicted in several graphical formats: hydrographs and hyetographs of sampling events, discharge rates, and precipitation events, and histograms of sample concentrations for all sampling events for the indicator contaminants, along with line plots, stacked bar charts, and scatter plots for the indicator contaminantss.

Hydrographs and Hyetographs: The hydrographs show the measured discharge rates during each surface water sampling event and the hyetographs show precipitation events and amounts to provide perspective on the timing of the sampling events and the specific conditions prior to, during, and after each event. These are provided as Figures 5.4-1 through 5.4-4.

Histograms: The histograms provide a graphical summary of the indicator contaminants for all the surface water sampling events. For each analyte, data are presented in two types of histograms: data sorted by flow event type (high flow, low flow, and storm water-influenced flow) and data sorted by location in the river channel (west and east channel and transect locations). For the XAD samples, the individual data points are composed of shaded stacked bars to distinguish between the dissolved (XAD column) and particulate (XAD filter) samples. The bars are color-coded to distinguish between the single point samples (blue) and the transect samples (orange). The non-detected samples are displayed with a hatch pattern or open bar. The same scheme is used for the peristaltic samples, with shaded stacked bars for total and dissolved fractions and blue and orange colors for the single point and transect samples. Multnomah Channel and Swan Island Lagoon are indicated by "MC" and "SIL", respectively, on the histograms.

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Line Plots: The line plots present the concentrations of the indicator contaminantss for each flow type (high flow, low flow, storm water-influenced) at the transect stations for all surface water sampling events. The squares, diamonds, and triangles represent the data points. Prior to generating the plots, data were averaged so that only one value per transect per sampling event was used. NB and NS total (dissolved plus particulate) concentrations were averaged for samples from stations W027 (Multnomah Channel), W005 (RM 4), W011 (RM 6.3), and W024 (RM 16) and east, west, and mid-channel total concentrations were averaged for stations W025 (RM 2) and W023 (RM 11), where applicable. The data for the 2007 high flow event is displayed in two colors because this event was completed in two phases with a stand down period between high flow conditions.

Scatter Plots: Scatter-plot presentations of the surface water data show concentrations of the indicator contaminants by river mile. The symbols on the scatter plots distinguish between flow types (high flow, low flow, storm water-influenced flow) and single-point and transect samples. The evaluation of hydrophobic indicator contaminants presents indicator contaminants relationships with flow, TSS, and organic carbon. Particulate versus dissolved concentrations are also presented for detailed evaluation of the results. The symbols on the scatter plots distinguish between flow types (high flow, low flow, storm water-influenced flow) and point and transect samples.

5.4.1 Surface Water Data Set

The Round 2A and 3A surface water sampling programs consisted of seven field collection events that occurred between November 2004 and March 2007. The seven events are listed below:

- November 2004 (Round 2A, low flow)
- March 2005 (Round 2A, low flow)

- July 2005 (Round 2A, low flow)
- January 2006 (Round 3A, high flow)
- September 2006 (Round 3A, low flow)
- November 2006 (Round 3A, storm water-influenced flow)
- January-March 2007 (Round 3A, high flow[1]).

Other studies included in this evaluation are:

- Siltronic – May and June 2005 (MFA 2005b, low flow).
- NW Natural – October 2007(Anchor 2008b, low flow).
- City of Portland – February 5, 1992 (low flow) and March 15, 2006 (low-flow) (Sanders 2006, TSS only).

Peristaltic and XAD (column and filter) samples were collected during all sampling events, but not at all sampling locations. Table 5.4-1 summarizes the sampling methods at each sampling station for each sampling event.

Surface water samples were collected at 23 target locations from RM 2 to 11 in the Lower Willamette River during three Round 2A sampling events in 2004 and 2005. Single-point samples were collected by peristaltic pump at all locations. Additional samples were collected by employing the high-volume XAD sampling method at seven of the 23 locations, including three cross-sectional river transects and four discrete locations. During the Round 3A sampling events, surface water was collected at 18 target locations from RM 2 to 16 in 2006 and 2007. A transect station located at the upper end of Multnomah Channel (RM 2.9) was added to the program to provide a better understanding of the flux of chemicals exiting the Study Area via Multnomah Channel; and a transect station at RM 16 was added to assist with the analysis of upstream sources and loading into the Study Area. Peristaltic and high-volume samples were collected from 18 stations, including 6 transects and 12 single-point locations. Table 5.4-1 summarizes sampling methods at each station for all Round 2A and 3A sampling events. Peristaltic surface water samples were analyzed for conventional analytes, metals, and organic compounds (PCB Aroclors, organochlorine pesticides, and SVOCs). High-volume samples were analyzed by high-resolution gas chromatography/high-resolution mass spectrometry (HRGC/HRMS) for PCB congeners, PCDD/Fs, organochlorine pesticides, phthalate esters, and PAHs.

For comparison of peristaltic and XAD data on the same basis, a summed XAD concentration was calculated from the XAD column and XAD filter concentrations. In

[1] The January 2007 high-flow event was cancelled after two days of sampling due to unexpected change in flow conditions. Sampling recommenced on February 21, 2007 once high-flow conditions (>50,000 cfs) were once again observed and continued through March 10, 2007.

this sum, non-detects were set to zero. If both XAD fractions were non-detect, the summed detection limit was set to the sum of the individual detection limits.

A total of six transect locations located at RM 2, mouth of Multnomah Channel, RM 3.9, RM 6.3, RM 11 and RM 16 were sampled; due to flow conditions and sample event objectives, not all transects were sampled during all sampling events. Transects were sampled in three ways: as a vertically-integrated equal discharge increment transect [EDI-VI]; as a near surface equal discharge increment transect and near bottom equal discharge increment transect pair [EDI-NS/NB]; and as a vertically-integrated, three segment (East, Mid-channel, West) transect [VI (E,M,W)][2]. At three locations (W010, W014, and W020) single point vertically-integrated samples were collected during Round 2A low flow conditions to support the baseline human health risk assessment. The remaining Round 2A single-point samples were collected in support of the baseline ecological risk assessment as near bottom samples. Round 3A single-point samples were collected as near surface and near bottom pairs. Siltronic collected peristaltic single point samples, and NW Natural and the City of Portland collected surface water grab samples. Not all samples were analyzed for every analyte. Each subsection that follows will discuss which samples were analyzed for each indicator contaminants.

A total of 23 peristaltic sample locations and seven peristaltic and XAD stations were sampled during the Round 2A low flow conditions and six peristaltic and XAD stations were sampled during the Round 3A low flow conditions (Table 5.4-2). Twenty single-point peristaltic stations (W001-W004, W006-W010, and W012-W022) and four single-point peristaltic and XAD stations were sampled (W013, W015, W016, W018) during each of the three Round 2A sampling events (Table 5.4-1). Both peristaltic and XAD samples were collected for all the low flow transect samples in Round 2A. Three Round 2A transect locations (W005, W011, and W023) were collected during low flow conditions as EDI-VI. Four Round 3A transect locations (W005, W011, W024, and W027) were collected as EDI-NS/NB and the other two Round 3A transect locations (W023 and W025) were collected as VI (E, M, W). Replicates were collected based on a 5% target frequency at the following single-point stations: W013 (peristaltic and XAD) and W016 (peristaltic only) during November 2004; W013 (peristaltic and XAD) and W002 (peristaltic only), W004 (peristaltic only), and W016 (peristaltic only) during March 2005; and W002 (peristaltic only) and W016 (peristaltic only) and W013 (peristaltic and XAD) during July 2005. A total of 92 peristaltic samples and 38 XAD samples were collected to represent the low flow conditions of the river (Table 5.4-3). As summarized in Table 5.4-4, samples collected during this flow regime include:

- 61 peristaltic and 15 XAD single-point, near-bottom samples;
- 8 peristaltic single-point, vertically-integrated samples;
- 9 peristaltic and 9 XAD transect, EDI-VI samples;

[2] A single vertically-integrated sample was collected from the mid-point of each transect segment.

- 2 peristaltic and 2 XAD east-channel VI transect samples, 2 peristaltic and 2 XAD mid-channel VI transect samples, and 2 peristaltic and 2 XAD west-channel VI transect samples;
- 4 peristaltic and 4 XAD transect, EDI-NS samples; and
- 4 peristaltic and 4 XAD transect, EDI-NB samples.

Storm water-influenced flow conditions were only sampled once during Round 3A (November 2006). Both peristaltic and XAD samples were collected at all six transect locations (W005, W011, W023, W024, W025, and W027) and 12 single-point stations (W026 and W028-W038) during this sampling event (Table 5.4-1). Four of the transect locations (W005, W011, W024 and W027) were sampled as EDI-NS/NB. The other two transect locations (W023 and W025) were sampled as VI (E, M, W). All the single-point samples were collected as NS/NB pairs. Replicates were collected at single-point stations W033 (peristaltic and XAD) and W036 (peristaltic only). A total of 42 peristaltic samples and 40 XAD samples were collected to represent the storm water-influenced flow conditions of the river (Table 5.4-3). As summarized in Table 5.4-4, samples collected during this flow regime include:

- 14 peristaltic and 13 XAD single-point, near surface samples;
- 14 peristaltic and 13 XAD single-point, near-bottom samples;
- 2 peristaltic and 2 XAD east-channel VI transect samples, 2 peristaltic and 2 XAD mid-channel VI transect samples, and 2 peristaltic and 2 XAD west-channel VI transect samples;
- 4 peristaltic and 4 XAD transect, EDI-NS samples; and
- 4 peristaltic and 4 XAD transect, EDI-NB samples.

High flow conditions were sampled twice during Round 3A (January 2006 and January-March 2007). In January 2006, peristaltic and XAD samples were collected at three transects (W005, W023, and W024). Due to safety concerns and sampling challenges associated with the extreme high flow conditions, the January 2006 samples were collected mid-channel at a single fixed depth for each of the three transect stations that were sampled. No vertical integration was performed. One replicate was collected at W023 for the peristaltic sample only. Both peristaltic and XAD samples were collected at all six transects and 12 single-point stations (W026 and W028-W038) during the January-March 2007 sampling event. Four of the transect locations (W005, W011, W024 and W027) were sampled as EDI-NS/NB. The other two transect locations (W023 and W025) were sampled as VI (E, M, W). Stations W023-M and W025-M were first sampled in January 2007, and then re-occupied in March 2007 (W023-M2, W025-M2) due to changing flow conditions. All the single-point samples were collected as NS/NB pairs. NS and NB replicates were collected at single-point station

W033 (peristaltic only) during the January-March 2007 event. A total of 46 peristaltic samples and 43 XAD samples were collected to represent the high flow conditions of the river (Table 5.4-3). As summarized in Table 5.4-4, samples collected during this flow regime include:

- 13 peristaltic and 12 XAD single-point, near surface samples;
- 13 peristaltic and 12 XAD single-point, near-bottom samples;
- 2 peristaltic and 2 XAD east-channel VI transect samples, 4 peristaltic and 2 XAD mid-channel VI transect samples, and 2 peristaltic and 2 XAD west-channel VI transect samples;
- 4 peristaltic and 4 XAD transect, EDI-NS samples; and
- 4 peristaltic and 4 XAD transect, EDI-NB samples.

Uncertainty associated with the surface water data is related primarily to the representativeness of the analytical data set. The surface water sampling program was designed to capture representative flow conditions and locations over time. However, only a limited number of surface water samples during a limited number of conditions could be collected over time. In addition, sampling protocols evolved over time based on the assessment of previous efforts as well changing river flow conditions. This evolution included some changes in both sample locations and sampling methods. While these changes were intended to more fully characterize the site, they also make the compilation and combination of these data more complex. For example, single point stations occupied in round 2 were sampled on multiple occasions. However, during round 3 the stations were shifted into deeper water to accommodate the round 3 modification to collect both near-bottom and near-surface samples simultaneously or relocated at EPA’s request. Also, while the six transects were sampled in almost all the sampling events, sampling methods were modified over the course of the sampling program. While the data evaluation compares concentrations at the river transects, there is uncertainty associated with the changes in sampling methods as well as the unavoidable flow condition differences between specific sampling events.

This complexity prohibits a quantitative statistical evaluation of temporal and flow variability in surface water. Further, the limited number of stations and samples preclude definition of the magnitude and extent of the surface water contamination in all localized areas. Such locations may need to be addressed further in remedial design. Nonetheless, the data collected and presented here met the objectives of the sampling program and are sufficient for the purposes of the site-wide RI.

5.4.2 River Conditions during Round 2A and 3A Sample Collection

A summary of the sampling events, including dates of collection, flow rates, and relative flow conditions, are presented in Table 5.4-5. Average discharge rates (recorded as cfs) for each event are based on measurements collected by the USGS at the stream flow station located upstream of the Morrison Bridge at RM 12.8 (station 14211720). Flow measurements from the USGS gauge at this station are collected every 30 minutes and were used to calculate flow rates for each of the seven sampling events.[3] It should be noted that discharge rates below 20,000 cfs measured at this station are considered to be unreliable by the USGS. Therefore, the average discharge rates calculated for the low flow events should be considered estimates.

The surface water sampling events and their corresponding flow rates are presented against the backdrop of the average year (1972–2008) hydrograph measured at Morrison Bridge on Figure 5.4-1. Overall, the sampling events were well distributed over the average water year, capturing the range of flow conditions, including base flow, rising limb, peak flow, and falling limb conditions. Additionally, the November 2006 sampling captured a storm water-influenced flow event at the onset of the transition from a low flow period to a high flow period. Figures 5.4-2a-d present the actual annual hydrograph measured at Morrison Bridge (RM 12.8) and hyetograph during each year of sampling (2004–2007), including daily average and historical average (1978–2008) discharge rates and daily precipitation levels and identifies the sampling events collected during each year. Several rainfall events occurred during the November 2004 sampling event, and one day of measurable rainfall occurred during each of the March and July 2005 sampling events.

The seasonal cycle of water discharge in the Willamette River is also apparent on Figure 5.4-1. Annual low water levels occur during the summertime regional dry season, and flows increase during the wetter winter months (November to March). Furthermore, a distinct and persistent period of relatively high water levels occurs from late May through June when Willamette River flow into the Columbia is slowed by high-water stage/flow in the Columbia River during the spring freshet in the much larger Columbia River Basin. The flow regime can influence the concentration of contaminants in the water column.

Flow measurements were not collected at the lower end of the Study Area where the river flows either into the Columbia River or into Multnomah channel. To better understand the flow dynamics at the lower end of the Study Area, a hydrodynamic model (discussed in Section 6) was used to estimate these flows. The model shows that the relative stages of the Columbia and Willamette rivers determine the fraction of the Willamette River flow which flows down Multnomah Channel (WEST 2006a). Figure 5.4-3 presents the average annual hydrograph, based on modeled discharge rates for 2003 through 2007, for RM 4, RM 2, and Multnomah Channel. The Morrison Bridge (RM 12.8) 25-yr average hydrograph is also shown for comparison.

Figure 5.4-4 presents the modeled daily average flows for 2003 through 2007 and highlights the time periods when surface water samples were collected at RM 4, RM 2, and Multnomah Channel. A few key observations are apparent in these figures. First, for a significant portion of each year, generally May through September, the relatively higher Columbia River stage drives a reversal in flow direction at RM 2. During these periods, the Multnomah Channel flow increases and includes the entire Willamette River flow plus some flows from the Columbia River. Second, Figure 5.4-4 shows that surface water sampling events at the RM 2 and Multnomah Channel sample transects did not occur during these flow reversal periods; rather, sampling was conducted when the Willamette River flow was in the downstream direction, and flows split between Multnomah Channel and the main stem. This indicates that surface water samples collected at RM 2 and Multnomah Channel are representative of Willamette River water and are not strongly influenced by mixing with Columbia River water.

Tidal action also compounds the hydrology and interplay of the two rivers, and affects the Willamette River upstream as far as Portland Harbor and beyond. The high (i.e., flood) tide can influence Willamette River levels by up to 3 ft in Portland Harbor when the river is at a low stage. These tidal fluctuations can result in short-term flow reversals (i.e., upstream flow) in Portland Harbor during times of low river stage combined with large flood tides. Tidal changes were observed at multiple stations during the surface water sampling events. At this time, there is not adequate high-resolution discharge information to determine the potential influence of tidal fluctuations and water mixing on surface water sampling results; however, the overall tidal impact is not expected to be significant.

5.4.3 Suspended Solids

Suspended sediment loads are potentially an important component of the Lower Willamette River physical system. TSS data have been collected as part of the surface water data collection effort to understand distributions and patterns of contaminant concentrations. As stated in Section 3, evaluations overall indicate that a positive correlation exists between TSS concentrations and flow rate in the Lower Willamette River.

Organic carbon is present in both suspended sediment and the dissolved phase. This organic carbon comes from a range of natural sources including watershed inputs, such as the dissolution and decay of plant material and soil organic matter, and in-river sources such as phytoplankton. In some locations anthropogenic sources such as petroleum may be significant. Hydrophobic compounds, for example persistent organic pollutants, such as PCBs, dioxin/furans, and chlorinated pesticides, tend to accumulate in the organic fraction ($f_{oc)}$ of sediments and soils, although they can be present in aqueous solution due to due to the dissolved organic carbon (DOC) and the presence of colloids[4] in the water column. Organic carbon in the suspended sediment is a strong

[4]Colloids are the smallest particles, having dimensions between 1 nm and 100 µm; they are comprised of humic substances, Fe and Mn- oxides and soil-derived materials, and are ubiquitous in natural waters (Stumm, and

determinant in the adsorption of organic contaminants (i.e., persistent organic pollutants) with low aqueous solubility. DOC is important in the transport of metals in the aquatic systems. Metals can be strongly complexed by DOC, enhancing metal solubility while also reducing metal bioavailability.

Figures 5.4-5 and 5.4-6 present the f_{oc} on the TSS in each surface water sample as a function of flow rate and river mile, respectively. The surface water transect particulate and dissolved organic carbon data are presented by event on Figures 5.4-7 and 5.4-8. The f_{oc} values on the TSS range from 0 to 20 percent in the low flow samples and 0 to 50 percent in the storm water-influenced samples. Conversely, the f_{oc} on the TSS in high flow samples is distinctly lower, ranging from 0 to less than 4 percent, suggesting the introduction of suspended particles with low organic carbon content during high flow events. Generally low f_{oc} values may be a function of larger particles (lower surface area per volume and therefore fewer organic carbon binding sites) introduced during high flow conditions.

Figure 5.4-9 presents a scatter plot of f_{oc} and TSS that summarizes the overall trend of solids concentrations and f_{oc} in the data set. High flow samples tend to exhibit lower f_{oc} associated with TSS. The shape of the curve is largely driven by the fact that f_{oc} is a function of TSS. The suspended solids associated with the storm water-influenced samples appear to have the highest levels of organic carbon content. The TSS concentrations and corresponding f_{oc} values vary somewhat between flow types, and the low flow samples appear to fall between the high flow and storm water-influenced samples based on the level of organic carbon. There is the possibility that there may be local nearshore effects at the point of discharge that were not captured in the surface water sampling data set.

5.4.4 Total PCBs in Surface Water

Total PCB data are summarized in Tables 5.4-6 through 5.4-11. Transect samples are summarized by flow event in Tables 5.4-6, 5.4-8, and 5.4-10. Single-point samples are summarized by flow event in Tables 5.4-7a-d, 5.4-9a-d, and 5.4-11a-d. All PCB surface water sample results are presented in Table 5.4-12 by sample event and sample ID number.

Dissolved and particulate PCB congener concentrations in surface water XAD columns and filters and PCB Aroclor concentrations from the peristaltic pumps are presented in stacked bar graphs by flow event and by river mile/channel position on Figures 5.4-10 and 5.4-11.

Total PCB concentrations at the transect locations as a function of flow rate is presented on Figure 5.4-12. The data points presented in this figure are averages of all data points collected at a particular transect for each measured flow event.

Morgan, 1996). A fraction of colloids are small enough to pass through a 0.45 µm filter materials; as such, compounds sorbed to, or comprising, colloids are operationally part of the 'dissolved' fraction.

Figures 5.4-13a-b present a scatter plot of all total PCB surface water data. Note the symbols and colors indicate the sample type—point vs. transect—and the general flow conditions of the sampling event—low flow, storm water-influenced, or high flow.)

5.4.4.1 Total PCB Data

Total PCBs were analyzed as PCB Aroclors by EPA method 8081 in 53 of the total 180 peristaltic samples collected; 42 SP-NB samples, eight SP-VI samples, and three transect EDI-VI sample. High-volume surface water samples (XAD samples) were analyzed as PCB congeners by HRGC/HRMS in 120.5[5] of the total 121 XAD samples collected; 25 SP-NS samples, 39.5 SP-NB samples, 32 transect EDI-VI samples, 12 transect EDI-NS samples, and 12 transect EDI-NB samples.

PCB Aroclors were not detected in the majority of the peristaltic samples (47 of 53 nondetect samples) with detection limits ranging from 0.0025 to 0.0027 µg/L, which is four orders of magnitude greater than the Oregon water quality criterion for human health (6.4×10^{-6} µg/L), although below the chronic Oregon water quality criterion for aquatic life (0.014 µg/L) and the MCL (0.5 µg/L).

Detections of PCB Aroclors were limited to six single-point samples collected during the Round 2A low flow event at the following stations:

- W001 (RM 2.0E),
- W004 (RM 3.7E-head of International Slip),
- W014 (RM 6.9E) and
- W022 (RM 9.7W).

Detected PCB Aroclor concentrations for SP-NB samples range from 0.0059 J µg/L to 0.0149 J µg/L; only one SP-VI sample (W014) was detected at 0.017 µg/L.

Total PCB congener concentrations, calculated as the sum of the dissolved (XAD column) and particulate (XAD filter) concentrations, were detected in all samples. The following discussion is based on the Total PCB congener data.

5.4.4.2 PCB Relationships to River Flow Conditions

Total PCB concentrations in samples collected during low flow conditions ranged as follows, sample types not samples are also listed:

- SP-NS: Not sampled;
- SP-NB: 0.000375 J µg/L to 0.01198 J µg/L (station W013 at RM 6.9E);

[5] Only the column of the XAD sample collected during July 2005 low flow event was analyzed for total PCBs; the filter was not analyzed.

Commented [Integral3]: In the sections that follow, sample counts and values were checked versus the SCRA database. Where inconsistencies were found, updates were made to counts/values in RLSO. We have not attempted o diagnose the source of each revision. However, in the section 5.4 tables provided by EPA on 6/11/2014 two issues were encountered that are likely relevant. The first is that it appears that values for summed parameters match values from the SCRA for the RA summing rules, not the RI summing rules. Second, there are some inaccuraciess in the assignment of the collection type description (point vs. transect locations).

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- T-VI: 0.000274 J µg/L to 0.000950 J µg/L (station W023E at RM 11);
- T-EDI/NS: 0.000159 J µg/L to 0.000673 J µg/L (station W011 at RM 6.3);
- T-EDI/NB: 0.000174 J µg/L to 0.000950 J µg/L (station W005 at RM 3.9); and
- T-EDI/VI: 0.000171 J µg/L to 0.000608 J µg/L (station W023 at RM 11).

Total PCB concentrations in samples collected during storm water-influenced flow conditions ranged as follows:

- SP-NS: 0.000182 J µg/L to 0.002586 J µg/L (station W030 at RM 5.5E);
- SP-NB: 0.000112 J µg/L to 0.000897 J µg/L (station W026 at RM 2.1E);
- T-VI: 0.000121 J µg/L to 0.001290 J µg/L (station W025E at RM 2);
- T-EDI/NS: 0.000149 J µg/L to 0.000458 J µg/L (station W005 at RM 3.9);
- T-EDI/NB: 0.000205 J µg/L to 0.000440 J µg/L (station W005 at RM 3.9); and
- T-EDI/VI: Not sampled.

Total PCB concentrations in samples collected during high flow conditions, excluding the 2006 high flow event, ranged as follows:

- SP-NS: 0.000111 J µg/L to 0.000749 J µg/L (station W035 in Swan Island Lagoon);
- SP-NB: 0.000149 J µg/L to 0.000703 J µg/L (station W035 in Swan Island Lagoon);
- T-VI: 0.000042 J µg/L to 0.000169 J µg/L (station W023E at RM 11);
- T-EDI/NS: 0.0000783 J µg/L to 0.000250 J µg/L (station W027 in Multnomah Channel);
- T-EDI/NB: 0.000705 J µg/L to 0.000391 J µg/L (station W005 at RM 3.9); and
- T-EDI/VI: Not sampled.

PCB concentrations were consistently lower in high flow samples compared to the low flow and storm water-influenced flow samples (Figure 5.4-12), suggesting dilution at high flow rates overwhelm local effects and PCB concentrations. All sample events show the concentrations at the RM 11 transect are consistently greater than RM 16 transect (Figure 5.4-12), indicating there are inputs of PCBs to the system in this reach.

During three of the four low flow sampling events (March 2005, July 2005, and September 2006), concentrations increase between RM 11 and RM 6. However, the November 2004 low flow event did not show this same trend. Two of the low flow events (July 2005 and September 2006) show sustained elevated concentrations between RM 6 and RM 4.

The February 2007 high flow sampling event shows increasing concentrations between RM 6 and RM 4; this trend is also apparent in the November 2006 storm water-influenced flow event. Only the storm water-influenced event shows increasing concentrations between RM 4 and RM 2.Two of the three highest total PCB concentrations at RM 11 were from the sampling stations on the east side of the channel (Figure 5.4-10). The second highest result at RM 11 was from a Round 2A vertically- and horizontally-integrated transect, and the field crew noted storm water runoff entering the east side of the channel during collection of this sample (Jones 2007, pers. comm.).

5.4.4.3 Spatial Distribution of PCBs

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None of the sample results exceeds the MCL for PCBs (0.5 µg/L). Total PCB Aroclor results from two sample stations exceeded the chronic ODEQ WQC for aquatic life (0.014 µg/L): W004 (RM 3.7 at the head of International Slip) and W014 (RM 6.9E in Willamette Cove). All the sample results exceed the ODEQ WQC for human health (0.0000064 µg/L) by one to four orders of magnitude. The majority of the highest total PCB concentrations (>0.001 µg/L) were associated with single-point samples collected during low flow conditions.

The highest detected concentrations (>0.01 µg/L) were collected at the following stations:

- W004 (RM 3.7E at the head of International Slip),
- W013 and W014 (RM 6.9E in Willamette Cove).

The next highest detected concentrations (between 0.01 and 0.001 µg/L) were collected at the following stations during low flow conditions:

- W001 (RM 2.0E),
- W015 (RM 6.9W),
- W016 (RM 7.2W),
- W018 (in Swan Island Lagoon),
- W022 (RM 9.7W),

and during the storm water-influenced flow event at the following stations:

- W025E (RM 2.0),
- W028 (RM 3.6E), and
- W030 (RM 5.5).

These data suggest that local PCB sources may exist in these regions of the Study Area. The range of total PCB concentrations within the complete data set across the Study Area was fairly consistent between RM 11 and 2 (Figure 5.4-13a and b), excluding the highest single-point concentrations, and elevated concentrations near the east side of the river at RM 6.7. Within the Study Area, total PCB concentrations continued to increase between RM 11 and RM 4 in six of seven transect-based sampling events (the sole exception is the November 2004 low-flow sampling event). Total PCB concentrations at both RM 2 and in Multnomah Channel transects generally decreased from those at RM 4 but remained higher than those at RM 16. An exception to this was the RM 2 total PCB concentration from the November 2006 stormwater-influenced event, which was higher than other transect concentrations measured in that event.

5.4.5 Total PCDD/Fs and TCDD TEQ in Surface Water

Total PCDD/F and TCDD TEQ data are summarized in Tables 5.4-6 through 5.4-11. Transect samples are summarized by flow event in Tables 5.4-6, 5.4-8, and 5.4-10. Single-point samples are summarized by flow event in Tables 5.4-7a-d, 5.4-9a-d, and 5.4-11a-d. All PCDD/F and TCDD TEQ surface water sample results are presented in Tables 5.4-13 and 5.4-14 by sample event and sample ID number.

Dissolved and particulate PCDD/F congener concentrations in surface water XAD columns and filters and concentrations from the peristaltic pump samples are presented in stacked bar graphs by flow event and by river mile/channel position on Figures 5.4-14 and 5.4-15. Dissolved and particulate TCDD TEQ concentrations in surface water are presented similarly on Figures 5.4-18 and 5.4-19.

Total PCDD/F concentrations at the transect locations as a function of flow rate is presented on Figure 5.4-16. The data points presented in this figure are averages of all data points collected at a particular transect for each measured flow event.

Figure 5.4-17 presents a scatter plot of all Total PCDD/F surface water data. Note the symbols and colors indicate the sample type—point vs. transect—and the general flow conditions of the sampling event—low flow, storm-water-influenced, or high flow).

5.4.5.1 Total PCDD/Fs and TCDD TEQ Data

5.4.5.1.1 Total PCDD/Fs Data

Total PCDD/Fs were analyzed as PCDD/F congeners in high-volume surface water samples by HRGC/HRMS in 79 of the total 121 XAD samples collected; 7 SP-NS samples, 16 SP-NB samples, 12 transect EDI-VI samples, 20 SP-VI samples, 12 transect EDI-NS samples, and 12 transect EDI-NB samples. Total PCDD/F congener concentrations, calculated as the sum of the dissolved (XAD column) and particulate (XAD filter) concentrations, were detected in all samples.

5.4.5.1.2 TCDD TEQ Data

TCDD TEQ were calculated in 79 of the total 123 XAD samples collected; 7 SP-NS samples, 16 SP-NB samples, 12 transect EDI-VI samples, 20 SP-VI samples, 12 transect EDI-NS samples, and 12 transect EDI-NB samples. Stacked bar graphs depicting TCDD TEQ concentrations in the surface water dissolved (XAD column) and particulate (XAD filter) samples by flow condition and river mile are presented on Figures 5.4-18 and 5.4-19. TCDD TEQ concentrations, calculated as the sum of the dissolved (XAD column) and particulate (XAD filter) TCDD toxicity equivalent concentrations of each dioxin/furan congener, were detected in all samples.

5.4.5.2 PCDD/F and TCDD TEQ Relationships to River Flow Conditions

5.4.5.2.1 PCDD/F Relationship to River Flow Conditions

Total PCDD/F concentrations in samples collected during low flow conditions ranged as follows:

- SP-NS: Not sampled;
- SP-NB: 0.000031 µg/L to 0.000162 µg/L (station W013 at RM 6.9E);
- T-VI: 0.000006 J µg/L to 0.000027 J µg/L (station W023E at RM 11);
- T-EDI/NS: 8.49×10^{-6} J µg/L to 0.000026 J µg/L (station W027 in Multnomah Channel);
- T-EDI/NB: 9.31×10^{-6} J µg/L to 0.000052 J µg/L (station W005 at RM 3.9); and
- T-EDI/VI: 0.000017 J µg/L to 0.000050 J µg/L (station W005 at RM 3.9).

Total PCDD/F concentrations in samples collected during storm water-influenced flow conditions ranged as follows:

- SP-NS: 0.000036 J µg/L to 0.000054 J µg/L (station W035 in Swan Island Lagoon)
- SP-NB: 0.000039 µg/L to 0.000055 J µg/L (station W032 at RM 6.9E);
- T-VI: 5.51×10^{-6} J µg/L to 0.000118 µg/L (station W023E at RM 11);
- T-EDI/NS: 0.000019 J µg/L to 0.000052 µg/L (station W011 at RM 6.3);
- T-EDI/NB: 0.000026 µg/L to 0.000050 µg/L (station W005 at RM 3.9); and

- T-EDI/VI: Not sampled.

Total PCDD/F concentrations in samples collected during high flow conditions ranged as follows:

- SP-NS: 0.000025 µg/L to 0.000074 µg/L (station W035 in Swan Island Lagoon);
- SP-NB: 0.000027 J µg/L to 0.000075 µg/L (station W035 in Swan Island Lagoon);
- T-VI: 0.000005 J µg/L to 0.000031 J µg/L (station W023E at RM 11);
- T-EDI/NS: 0.0000097 J µg/L to 0.000030 J µg/L (station W027 in Multnomah Channel);
- T-EDI/NB: 0.000008 J µg/L to 0.000029 µg/L (station W027 in Multnomah Channel); and
- T-EDI/VI: Not sampled.

Figure 5.4-16 shows that there does not appear to be an overall trend between total PCDD/F values and flow conditions. All sample events show the concentrations at the RM 11 transect are consistently greater than concentrations at the RM 16 transect (Figure 5.4-16), indicating there are inputs of total PCDD/Fs to the system in this reach. During three of the four low flow sampling events (March 2005, July 2005, and September 2006), concentrations of PCDD/Fs increase between RM 11 and RM 6.3. The July 2005 low flow event show increasing concentrations between RM 6.3 and RM 3.9. The storm water-influenced flow event shows concentration peaks at RM 11 and RM 2; the February 2007 high flow event shows a similar pattern. Concentrations of PCDD/Fs leaving the Study Area in Multnomah Channel were consistently higher than RM 16 upstream of the Study Area, while concentrations at RM 2 were consistently lower than RM 16 and Multnomah Channel.

5.4.5.2.2 TCDD TEQ Relationship to River Flow Conditions

TCDD TEQ concentrations in samples collected during low flow conditions ranged as follows:

- SP-NS: Not sampled;
- SP-NB: 1.1×10^{-7} µg/L to 9.17×10^{-7} µg/L (station W013 at RM 6.9E);
- T-VI: 1.81×10^{-8} J µg/L to 6.43×10^{-8} J µg/L (station W023E at RM 11);
- T-EDI/NS: 2.69×10^{-8} J µg/L to 9.17×10^{-8} J µg/L (station W027 in Multnomah Channel);

- T-EDI/NB: 3.14×10^{-8} J µg/L to 1.97×10^{-7} J µg/L (station W005 at RM 3.9); and
- T-EDI/VI: 4.3×10^{-8} J µg/L to 3.27×10^{-7} J µg/L (station W005 at RM 3.9).

TCDD TEQ concentrations in samples collected during storm water-influenced flow conditions ranged as follows:

- SP-NS: 7.77×10^{-8} J µg/L to 1.36×10^{-7} J µg/L (station W035 in Swan Island Lagoon);
- SP-NB: 1.01×10^{-7} µg/L to 2.12×10^{-7} J µg/L (station W033 at RM 7W);
- T-VI: 1.33×10^{-8} J µg/L to 2.78×10^{-7} µg/L (station W023E at RM 11);
- T-EDI/NS: 3.73×10^{-8} J µg/L to 1.38×10^{-7} µg/L (station W027 in Multnomah Channel);
- T-EDI/NB: 7.7×10^{-8} µg/L to 1.09×10^{-7} µg/L (station W027 in Multnomah Channel);
- T-EDI/VI: Not sampled.

TCDD TEQ concentrations in samples collected during high flow conditions, excluding the 2006 high flow event, ranged as follows:

- SP-NS: 5.09×10^{-8} µg/L to 1.68×10^{-7} µg/L (station W035 in Swan Island Lagoon);
- SP-NB: 4.91×10^{-8} J µg/L to 1.49×10^{-7} µg/L (station W035 in Swan Island Lagoon);
- T-VI: 1.13×10^{-8} J µg/L to 6.57×10^{-8} J µg/L (station W023E at RM 11);
- T-EDI/NS: 2.38×10^{-8} J µg/L to 6.73×10^{-8} J µg/L (station W027 in Multnomah Channel);
- T-EDI/NB: 1.65×10^{-8} J µg/L to 6.82×10^{-8} µg/L (station W005 at RM 3.9); and

T-EDI/VI: Not sampled.

5.4.5.3 Spatial Distribution of PCDD/F and TCDD TEQ

There are no ODEQ WQC for total PCDD/F. None of the sample results exceed the MCL for TCDD TEQ (3×10^{-5} µg/L) or the ODEQ chronic AWQC for aquatic life (3.8×10^{-5} µg/L). All the sample results exceed the ODEQ TCDD WQC for human health (5.1×10^{-10} µg/L) by one to three orders of magnitude. However, this value is significantly lower than analytical detection limits. The majority of the highest total concentrations (>1x10^{-7} µg/L) were associated with both transect and single-point samples collected predominantly during low flow and storm water-induced flow conditions.

The highest concentrations were collected at the following stations during low flow events:

- W005 (transect at RM 3.9),
- W011 (transect at RM 6.3),
- W013 (RM 6.9E), and
- W015 (RM 6.9W)

and during the storm water-influenced flow event at the following stations:

- W005 (transect at RM 3.9),
- W023 (RM 11E),
- W027 (transect in Multnomah Channel),
- W032 (RM 6.9E),
- W033 (RM 7.0W), and
- W035 (Swan Island Lagoon).

The only sample with a relatively high concentration collected during high flow events was in Swan Island Lagoon.

5.4.6 Total DDx in Surface Water

DDx data are summarized in Tables 5.4-6 through 5.4-11. Transect samples are summarized by flow event in Tables 5.4-6, 5.4-8, and 5.4-10. Single-point samples are summarized by flow event in Tables 5.4-7a-d, 5.4-9a-d and 5.4-11a-d. All DDx surface water sample results are presented in Table 5.4-15 by sample event and sample ID number.

Dissolved and particulate DDx concentrations in surface water XAD columns and filters and DDx concentrations from the peristaltic pumps are presented in stacked bar graphs by flow event on Figure 5.4-20 and by river mile/channel position on Figure 5.4-21.

Commented [Integral8]: Need clarification of whether list is for Total PCDD/F or TCDD TEQ. Location list has not been checked.

Commented [KK9R8]: I think this was for total PCDD/F, but Integral will check on whether this is for either or both total PCDD/F and TCDD TEQ.

Commented [Integral10]: All other summed parameters have retained 'Total' in name; unclear why this change has been made. Propose changing to Total DDx throughout

Commented [KK11R10]: OK to have total precede DDx to be consistent with terminology used in the RI report.

DDx concentrations at the transect locations as a function of flow rate are presented on Figure 5.4-22. The data points presented in this figure are averages of all data points collected at a particular transect for each measured flow event.

Figures 5.4-23a-b present a scatter plot of all DDx surface water data. Note the symbols and colors indicate the sample type—point vs. transect—and the general flow conditions of the sampling event—low flow, storm water-influenced, or high flow.)

5.4.6.1 DDx Data

DDx contaminants were analyzed by EPA method 8081A in 84 of the total 180 peristaltic samples collected; 59 SP-NB samples, 16 SP-NS samples, eight SP-VI samples, and one T-NS samples. High-volume surface water samples (XAD samples) were analyzed for DDx contaminants by AXYS Method MLA-028 (Rev 1 or 2) in 93 of the total 121 XAD samples collected; 26 SP-NB samples, 11SP-NS samples, 12 T-NB samples, 12 T-NS samples, and 32 T-VI samples.

Commented [RRL12]: Internal EPA Comment Specify more details about the method.

DDx contaminants were not detected in the majority of the peristaltic samples (55 of 84 nondetect samples) with detection limits ranging from 0.000472 to 0.0016 µg/L. Most of the detection limits are less than the chronic Oregon water quality criterion for aquatic life (0.001 µg/L for 4,4'-DDT); only five of the non-detect samples exceed 0.001 µg/L.

DDx contaminants were detected in all but one (LW3-W3023-M-F) of the XAD samples (column sample or filter sample).

5.4.6.2 DDx Relationships to River Flow Conditions

DDx concentrations are subsequently listed as measured in the peristaltic samples or calculated as the sum of the dissolved (XAD column) and particulate (XAD filter) concentrations. DDx concentrations in samples collected during low flow conditions ranged as follows (the station listed is for the maximum):

- SP-NB: 4.92×10^{-5} J µg/L to 0.0187 J µg/L (station W001 at RM 2.0E)
- SP-NS: Not sampled
- SP-VI: All samples non-detect peristaltic samples.
- T-NB: 6.86×10^{-5} J µg/L to 0.000546 J µg/L (station W005 at RM 3.9)
- T-NS: 6.02×10^{-5} J µg/L to 0.0005 J µg/L (station W027 at Multnomah Channel)
- T-VI: 4.28×10^{-5} J µg/L to 0.000322 J µg/L (station W025 W at RM 2)

Commented [Integral13]: The minimum values that have been replaced appear to be for the filter fraction only, not the sum of C+F. It is not consistent to combine/compare peristaltic total values with XAD sub-fractions. This comment applies to following HF and SI sections.

Commented [KK14R13]: Agreed that it should be column plus filter.

DDx concentrations in samples collected during storm water-influenced flow conditions ranged as follows (the station listed is for the maximum):

- SP-NB: 0.000101 J µg/L to 0.0047 J µg/L (station W037 at RM 9.6W)
- SP-NS: 0.0000767 J µg/L to 0.0026 J µg/L (stations W038 at RM 9.9E and station W036 at RM 8.6 W)
- SP-VI: Not sampled
- T-NB: 0.000092 J µg/L to 0.000201 J µg/L (station W011 at RM 6.3)
- T-NS: 0.00000580 J µg/L to 0.00015 J µg/L (station W027 in Multnomah Channel)
- T-VI: 0.0001 J µg/L to 0.000184 J µg/L (station W025 W at RM 2)

DDx concentrations in samples collected during high flow conditions ranged as follows (the station listed is for the maximum):

- SP-NB: 0.00018 J µg/L to 0.00205 J µg/L (station W037 at RM 9.6W)
- SP-NS: 0.00017 J µg/L to 0.00096 J µg/L (station W029 at RM 4.4W)
- SP-VI: Not sampled
- T-NB: 0.000375 J µg/L to 0.000578 J µg/L (station W005 at RM 3.9)
- T-NS: 0.000346 J µg/L to 0.000535 J µg/L (station W005 at RM 3.9)
- T-VI: 0.00016 J µg/L to 0.000618 J µg/L (station W005 at RM 3.9)

With the exception of the highest total DDx concentrations that were measured at RM 6.9 and 7.2 and a single high concentration measured at RM 2 (March 2005), the range of total DDx concentrations detected was fairly consistent. Total DDx concentrations in surface water transect stations (Figure 5.4-23a-b) were generally higher in high flow samples than in those associated with the low flow and storm water-influenced samples.

5.4.6.3 DDx Spatial Distribution

Results from twenty sample stations exceeded the chronic Oregon water quality criterion for aquatic life (0.001 µg/L for 4,4'-DDT) by a factor of 1 to 19.

The highest concentrations (>0.003 µg/L) were collected at the following stations during low flow events:

- W001 (RM 2.0E),
- W015 (RM 6.9W) on three dates, and

- W016 (RM 7.2W),

and during the storm water-influenced flow event at stations:

- W030 (RM 5.5E), and
- W037 (RM 9.6W).

5.4.7 The highest XAD concentrations were measured in single-point samples collected during low flow conditions near the middle of the Study Area at RM 6.9 (station W015; 0.00359 to 0.00766 µg/L) and RM 7.2 (station W016; 0.00124 J to 0.00976 µg/L). Excluding these higher concentrations, the overall range of observed concentrations across the Study Area and upstream to RM 16 was fairly consistent. High flow transect samples showed upstream concentrations that were greater than low flow and stormwater influenced concentrations in the study area (Figure 5.4-22). The storm water-influenced and low flow sample increased between rivermiles 11 and 6; and decreased downstream, **Total PAHs in Surface Water**

PAH data are summarized in Tables 5.4-6 through 5.4-11. Transect samples are summarized by flow event in Tables 5.4-6, 5.4-8, and 5.4-10. Single point samples are summarized by flow event in Tables 5.4-7a-d, 5.4-9a-d, and 5.4-11a-d. All PAH surface water samples are presented in Table 5.4-16 by sample event and sample ID number.

Dissolved and particulate PAH concentrations in surface water XAD columns and filters and PAH concentrations from the peristaltic pump samples are presented in stacked bar graphs by flow event in Figures 5.4-24 and by river mile/channel position in Figures 5.4-25.

PAH concentrations at the transect locations as a function of flow rate are presented in Figure 5.4-26. The values presented in this figure are averages of all measurements collected at a particular transect for each measured flow event.

Figure 5.4-27 presents a scatter plot of all PAH surface water data. Note the symbols and colors indicate the sample type—point vs. transect—and the general flow conditions of the sampling event—low flow, storm water-influenced, or high flow.

5.4.7.1 Total PAH Data

PAHs were analyzed by HRGC/LRMS in 174 of the 180 samples;[6] 83 SP-NB, 26 SP-NS, 8 SB-VI, 12 T-NB, 12 T-NS, and 33 T-VI samples. High-volume surface water samples (XAD samples) were analyzed by HRGC/HRMS in 85 of the total 121 XAD samples; 22 SP-NB, 7 SP-NS, 12 T-NB, 12 T-NS, and 32 T-VI samples.

[6] Sample events could involve replicate samples, and for XAD sampling the column and filter samples together are counted as one sample. These counts are strictly of sample events, and the values listed here are with replicates averaged together.

Commented [EACC15]: Internal EPA Comment
Discrepancies:
[This is not necessarily a complete set of discrepancies of the same nature; they are just those noticed in passing – a complete analysis for these types of discrepancies has not been performed.]
1. We don't have any data for WO24 (mile 16) in the database.
2. Map 5.3-1a lists WO38 at mile 9.9 (placing it on the E side of the river). The database we have lists it at mile 11E.
3. Map 5.3-1a plots WO38 as a green triangle, corresponding to XAD SP (according to the legend). Our database lists WO38 as Peristaltic SP.
4. The total PAH measured by XAD (C+F) and Peristaltic are highly discrepant. For the 61 cases testable in our database, 29 are discrepant by more than a factor 2 --- i.e. if both are detects (13 cases), the concentrations differ by mor)e than a factor of 2; if one is a non-detect, the other a detect (16 cases), then the detect exceeds the DL of the non-detect by a factor more than 2. It is possible some of this discrepancy may be an artefact of the method of summing across the multiple PAH (i.e. treatment of non-detects).
5. In view of the discrepancy above, any conclusions based on trends is suspect.
6. Moreover, the apparent trends downriver seen in the XAD (C+F) and Peristaltic measurements are different in some cases, so that conclusions based on one or the other are suspect.
7. the database contains XAD – C, XAD – F, and XAD – C&F, but the last is not necessarily equal to the sum of the first two, with the discrepancy larger than can be accounted for by simple rounding of the data. This discrepancy may be explicable by the methodology used to sum across PAH (e.g. treatment of non-detects). For this section the XAD – C&F total has been replaced by the sum of XAD – C and XAD – F.

Commented [Integral16]: Sample counts for this, and all analytes, have been QA'd and revised. In all cases, revised counts represent the summed total of normal samples and field replicates. Field replicates included for transparency and consistency.

New definition of sample events in this section; inconsistent with previous sections which described total samples; sampling events defined differently in previous sections and in Section 2 text revised by EPA.

PAHs were detected in over half of the peristaltic samples (101 of 174 samples) with detection limits for the non-detects ranging from 0.0065 to 0.043 µg/L. PAHs were detected in all the XAD samples (column sample or filter sample or both). The detection limits in non-detect peristaltic samples were well below the MCL for benzo(a)pyrene (0.2 µg/L). The highest detected PAH value of 7.4 µg/L (station W031 at RM 6.1) is well below the Oregon-specific water quality guidance for freshwater aquatic life the only two PAH for which there is any such guidance (acenaphthene: 520 µg/L, and naphthalene: 620 µg/L).

Detected PAH concentrations are subsequently listed as measured in the peristaltic samples or calculated as the sum of the dissolved (XAD column) and particulate (XAD filter) concentrations.

5.4.7.2 PAH Relationships to River Flow Conditions

Detected PAH concentrations in samples collected during low flow conditions ranged as follows (the station listed is for the maximum):

- SP-NB: 0.0026 J µg/L to 2.5 J µg/L (station W012 at RM 6.3W)
- SP-NS: Not sampled
- SP-VI: 0..0049 J µg/L to 0.0413 J µg/L (station W020 at RM 9.1 (Swan Island Lagoon))
- T-NB: 0.0045 J µg/L to 0.0661J µg/L (station W005 at RM 3.9)
- T-NS: 0.0061 J µg/L to 0 J µg/L (station W027 at RM Multnomah Channel)
- T-VI: 0.0039 J µg/L to 0.065 J µg/L (station W023 at RM 11)

PAH concentrations in samples collected during storm water-influenced flow conditions ranged as follows (the station listed is for the maximum):

- SP-NB: 0.0059 J µg/L to 0.045J µg/L (Station W033at RM 7.0W)
- SP-NS: 0.0061 J µg/L to 0.0507 J µg/L (Station W033at RM 7.0W)
- SP-VI: Not sampled
- T-NB: 0.0041J µg/L to 0.029 J µg/L (Station W005 at RM 3.9)
- T-NS: 0.00129 J µg/L to 0.0389 J µg/L (Station W005 at RM 73.9)
- T-VI: 0.00279 J µg/L to 0.022J µg/L (Station W025E at RM 2)

Commented [KK17]: Should this E be here or deleted?

PAH concentrations in samples collected during high flow conditions ranged as follows (the station listed is for the maximum):

- SP-NB: 0.00104 J µg/L to 7.4 J µg/L (Station W031 at RM 6.1W)
- SP-NS: 0.0047 J µg/L to 0.27 J µg/L (Station W036 at RM 8.6W)
- SP-VI: Not sampled
- T-NB: 0.0086 J µg/L to 0.023 µg/L (Station W005 at RM 3.9)
- T-NS: 0.0064 J µg/L to 0..021 J µg/L (Station W005at RM 3.9)
- T-VI: 0.0056 J µg/L to 0.059 J µg/L (Station W005 at RM 3.9)

PAH concentrations were generally higher in low flow samples as compared to the high flow and storm water-influenced flow samples, suggesting that inflow concentrations at high flow rates overwhelm local effects and dilute the PAH concentrations (Figure 5.4-24). For all but storm water events the transect samples (Figure 5.4-26) show slightly increased concentrations between the RM 11 and RM 16 transects), indicating there may be inputs of PAHs to the system in this reach. Some events, three of the four low flow sampling events (November 2004, July 2005, and September 2006), one high flow event (January 2006), and the storm water event (November 2006), show increases in concentrations between RM 11 and RM 6. However, the March 2005 low flow event did not show this same trend. Two of the low flow events (July 2005 and September 2006), the stormwater events (November 2006), and one of the high flow events (February 2007) show increasing concentrations between between RM 6 and RM 4.

Commented [EACC18]: Internal EPA Comment
Figure 5.3-87 (now 5.4-27) does not specify what data were used to construct it. It appears to be based on XAD (C+F) data only, and should require T-VI data. But Figure 5.3-87 shows data points at miles 3 and 4 although there are no T-VI data at miles 3 and 4 in our database.

5.4.7.3 Spatial Distribution of PAHs

Elevated sample concentrations for total PAHs were recorded at the following stations:

- W031 (RM 6.1W) 7.4 µg/L (February 2007, high flow)
- W012 (RM 6.3W) 2.5 µg/L (July 2005, low flow)
- W012 (RM 6.3W) 1.3 µg/L (November 2004, low flow)
- W021 (RM 8.7 in Swan Island Lagoon) 0.288 µg/L (July 2005, low flow)
- W036 (RM 8.6W) 0.27 µg/L (February 2007, high flow)
- W015 (RM 6.9W) 0.231 µg/L (July 2005, low flow)

All but the last of these were measured in Persistaltic samples. The first three appear to be outliers on the distribution of Peristaltic samples. All measured concentrations are below the two ODEQ guidance values for freshwater aquatic life (acenaphthene: 520 µg/L, and naphthalene: 620 µg/L).

5.4.8 BEHP in Surface Water

BEHP data are summarized in Tables 5.4-6 through 5.4-11. Transect samples are summarized by flow event in Tables 5.4-6, 5.4-8, and 5.4-10. Single-point samples are summarized by flow event in Tables 5.4-7a-d, 5.4-9a-d, and 5.4-11a-d. All BEHP surface water sample results are presented in Table 5.4-17 by sample event and sample ID number.

Dissolved and particulate BEHP concentrations in surface water XAD columns and filters and BEHP concentrations from the peristaltic pumps are presented in stacked bar graphs by flow event and by river mile/channel position on Figures 5.4-28 and 5.4-29, respectively.

BEHP concentrations at the transect locations as a function of flow rate are presented on Figure 5.4-30. The data points presented in this figure are averages of all data points collected at a particular transect for each measured flow event.

Figure 5.4-31 presents a scatter plot of all BEHP surface water data. Note the symbols and colors indicate the sample type—point vs. transect—and the general flow conditions of the sampling event—low flow, storm water-influenced, or high flow.

5.4.8.1 BEHP Data

BEHP was analyzed by EPA methods 8270C or 525.2 in 174 of the total 180 peristaltic samples collected; 83 SP-NB samples, 26 SP-NS samples, eight SP-VI samples, 12 T-NB samples, 12 T-NS samples, and 33 T-VI samples. BEHP was analyzed in high-volume surface water samples (XAD samples) by AXYS Method MLA-027 Rev 01 in 24 of the total 121 XAD samples collected; 15 SP-NB samples and nine T-VI samples.

Commented [RRL19]: Internal EPA Comment What type of analysis is this?

BEHP was not detected in the majority of the peristaltic samples (158 of 174 samples) with detection limits ranging from 0.098 to 4.1 µg/L.

Detections of BEHP were limited to 15 samples collected during the Round 3A sampling event at the following stations:

- W005 (T-NS and T-NB; RM 3.9),
- W011 (T-NB; RM 6.3),
- W023 (T-VI; RM 11 M),
- W024 (T-NB; RM 16),
- W025 (T-VI; RM 2E and W),

- W027 (T-NB; Multnomah Channel),
- W029 (SP-NB; RM 4.4W),
- W032 (SP-NB; RM 6.7E),
- W033 (SP-NS; RM 7.0W), and
- W036 (SP-NS; RM 8.6W).

Detected BEHP concentrations in peristaltic samples ranged from 0.7 µg/L to 6.8 J µg/L. During low flow conditions, BEHP was detected in four samples at concentrations ranging from 0.7 µg/L to 1.5 µg/L (T-VI sample; station W025 Eat RM 2). During storm water-influenced flow conditions, BEHP was detected in one T-NB sample at a concentration of 6.8 J µg/L (station W005 at RM 3.9). During high flow conditions, BEHP was detected in 11 samples at concentrations ranging from 0.98 J µg/L to 3.5 J µg/L (SP-NB sample; station W032 at RM 6.7E).

BEHP concentrations, calculated as the sum of the dissolved (XAD column) and particulate (XAD filter) concentrations, were detected in nine of 24 samples, all collected during low flow conditions. BEHP concentrations in these samples ranged as follows:

- SP-NB: 0.0078 J µg/L to 0.033 µg/L (station W015 at RM 6.9W);
- T-VI: 0.0091 J µg/L to 0.023 J µg/L (station W023 at RM 11); and
- SP-NS, SP-VI, T-NS, T-NB: No detects.

5.4.8.2 BEHP Relationship to River Flow Conditions

Detected BEHP concentrations and frequencies were relatively consistent regardless of flow rate. The frequency of detection was 5% for low flow event peristaltic sampling results; 24% for high flow event peristaltic sampling results; 3% for storm water flow peristaltic sampling events, and 38% for low flow event XAD sampling results.

Detected BEHP concentrations in low flow peristaltic samples ranged from 0.7 to 1.5 µg/L (station W025 E at RM 2) in September 2006. Detected BEHP concentrations in high flow peristaltic samples ranged from 0.98 J to 3.5 J µg/L (station W032 at RM 6.9E) in February 2007. BEHP was detected in only one of 37 storm water-influenced flow samples at a concentration of 6.8 J µg/L (station W005 at RM 3.9) in November 2006.

Detected BEHP concentrations in low flow XAD samples ranged from 0.0078 J µg/L to 0.033 µg/L (station W015 at RM 6.9W).

5.4.8.3 Spatial Distribution of BEHP

One sample result exceeds the MCL for BEHP (6 µg/L). All the detected peristaltic and three detected XAD samples exceed the ODEQ human health criteria of 0.2 µg/L. The highest concentrations (>3 µg/L) were collected at the following stations:

- W005 (RM 3.9),
- W032 (RM 6.9E).

The next highest concentrations (>1.5 µg/L but <3 µg/L) were collected at the following stations during high flow conditions:

- W036 (RM 8.6W),
- W011 (RM 6.3),
- W024 (RM 16),
- W029 (RM 4.4W), and
- W025 (RM 2E).

5.4.9 Total Chlordanes in Surface Water

Total chlordanes data are summarized in Tables 5.4-6 through 5.4-11. Transect samples are summarized by flow event in Tables 5.4-6, 5.4-8, and 5.4-10. Single-point samples are summarized by flow event in Tables 5.4-7a-d, 5.4-9a-d, and 5.4-11a-d. All chlordanes surface water sample results are presented in Table 5.4-18 by sample event and sample ID number.

Total chlordanes concentrations in surface water XAD columns and filters as well as concentrations from the peristaltic pumps are presented in stacked bar graphs by flow low flow, storm water-influenced, or high flow events and by river mile/channel position on Figures 5.4-32 and 5.4-33, respectively.

Total chlordane concentrations at the transect locations as a function of flow rate is presented on Figure 5.4-34. The data points presented in this figure are averages of all data points collected at a particular transect for each measured flow event.

Figure 5.4-35 presents a scatter plot of total chlordane surface water data. Note the symbols and colors indicate the sample type—point vs. transect—and the general flow conditions of the sampling event—low flow, storm water-influenced, or high flow).

5.4.9.1 Total Chlordanes Data

Total chlordanes were analyzed by EPA Method 8081A for all of the 84 of 180 peristaltic samples collected. High-volume surface water samples (XAD samples) were analyzed for total chlordanes by the AXYS method for pesticides for 93 of 121 XAD samples collected.

Chlordanes were not detected in the majority of the peristaltic samples (78 of 84 nondetect samples) with total chlordane concentrations ranging from 0.00029 µg/L to 0.0021 µg/L and detection limits for undetected results ranging from 0.000472 to 0.0024 µg/L. Total chlordanes were detected in all 93 XAD column (dissolved) samples with detected concentrations ranging from 6.72×10^{-6} µg/L to 5.57×10^{-5} µg/L. Total chlordanes were detected in XAD samples at concentrations ranging from 7.32×10^{-6} to 2.41×10^{-4} µg/L. All of these detected and undetected results are below the acute (2.4 µg/L) and chronic (0.0043 µg/L) Oregon water quality criteria for aquatic life as well as the MCL (2 µg/L. All of the peristaltic detected and undetected results are greater than the Oregon water quality criterion for human health (0.000081 µg/L) that is protective of drinking water plus the consumption of organisms. The majority of the XAD samples, calculated as the sum of the XAD column and XAD filter, are less than this criterion; only six sample results exceed the criterion, with concentrations ranging from 0.000083 µg/L to 0.00024 µg/L. These results suggest that the XAD samples analyzed using the AXYS method for pesticides achieved sufficiently low detection limits to determine that total chlordanes are below applicable human health and ecological criteria in the majority of samples.

5.4.9.2 Total Chlordanes Relationship to River Flow Conditions

Detected total chlordanes concentrations were relatively consistent, with concentrations slightly higher during high flow conditions. A total of twelve samples (six peristaltic, six XAD) exceed the ODEQ human health criterion of 8.1×10^{-5} µg/L. Of the samples that exceed the criterion and eight are from the high flow events conducted in February and March 2007, and there are two each from low flow and stormwater influenced events..

Detected total chlordane concentrations in samples collected during low-flow conditions ranged as follows (the station listed is for the maximum):

- SP-NB: 1.73×10^{-5} to 0.0021 µg/L (station W002, RM 2W)
- SP-NS: Not Sampled
- SP-VI: Not detected.
- Transect-NB: 2.23×10^{-5} to 5.88×10^{-5} µg/L (station W005, RM 3.9)
- Transect-NS: 2.27×10^{-5} to 4.48×10^{-5} µg/L (station W027 in Multnomah Channel)
- Transect-VI: 1.34×10^{-5} to 3.70×10^{-5} µg/L (station W011, RM 6.3)

Detected total chlordane concentrations in samples collected during high-flow conditions ranged as follows (the station listed is for the maximum):

- SP-NB: 4.46×10^{-5} to 0.0006 µg/L(station W030, RM 5.5E)
- SP-NS: 4.77×10^{-5} to 0.00051 µg/L (station W030, RM 5.5E)
- SP-VI: Not sampled.
- Transect-NB: 4.83×10^{-5} to 9.43×10^{-5} µg/L (station W005, RM 3.9)
- Transect-NS: 3.84×10^{-5} to 9.07×10^{-5} µg/L (station W005, RM 3.9)
- Transect-VI: 3.36×10^{-5} to 9.11×10^{-5} µg/L (station W023 E, RM 11)

Detected total chlordane concentrations in samples collected during stormwater influenced conditions ranged as follows (the station listed is for the maximum):

- SP-NB: 9.98×10^{-6} to 3.61×10^{-5} µg/L (station W033, RM 7W)
- SP-NS: 7.32×10^{-6} to 0.0016 µg/L (station W036, RM 8.6W)
- SP-VI: Not sampled.
- Transect-NB: 2.12×10^{-5} to 3.66×10^{-5} µg/L (station W027 in Multnomah Channel)
- Transect-NS: 1.66×10^{-5} to 3.76×10^{-5} µg/L (station W027 in Multnomah Channel)
- Transect-VI: 1.34×10^{-5} to 2.14×10^{-5} µg/L(station W023 E at RM 11).

5.4.9.3 Spatial Distribution of Total Chlordanes

None of the sample results exceed the 2 µg/L drinking water MCL for total chlordanes, or the ODEQ ecological acute (2.4 µg/L) or chronic (0.0043 µg/L) criteria for the protection of aquatic life. Each of the four detected concentrations from peristaltic samples exceed the ODEQ WQC for human health (0.000081 µg/L). Detection limits were higher for the peristalitic samples than the XAD samples. The samples with concentrations greater than the human health criterion were collected at the following stations:

- W002 (RM 2.2W),
- W029 4.4W, and
- W030 5.5E, NS and NB.

The sample from station W002 was collected during the low flow event conducted in July 2005 and the samples from stations W029 and W030 were collected during the high flow event conducted in March 2007.

Lower detection limits were achieved for the XAD samples. Total chlordanes were detected in each of the 76 XAD samples with concentrations in five samples slightly exceeding the AWQC for human health (0.000081 µg/L). The samples were collected at the following stations:

- W005 (RM 3.9) (two samples),
- W015 (RM 6.9W),
- W023E (RM 11E) and
- W031 (RM 6.1W),

The sample from station W015 was collected during low flow conditions in November 2004; the samples from stations W015 and W023 were collected during high flow conditions in March 2007. The sample from station W031 was collected during high flow conditions in February 2007. The low detection limits for the XAD samples and the low frequency of exceedance of the human health AWQC criterion suggest that specific inputs of total chlordanes do not exist in the Study Area. .

5.4.10 Aldrin In Surface Water

Aldrin data are summarized in Tables 5.4-6 through 5.4-11. Transect samples are summarized by flow event in Tables 5.4-6, 5.4-8, and 5.4-10. Single point samples are summarized by flow event in Tables 5.4-7a-d, 5.4-9a-d, and 5.4-11a-d. All aldrin surface water sample results are presented in Table 5.4-19 by sample event and sample ID number.

Dissolved and particulate aldrin concentrations in surface water XAD columns and filters and aldrin concentrations from the peristaltic pumps are presented in stacked bar graphs by flow event type on Figures 5.4-36 and by river mile/channel position on Figures 5.4-37.

Aldrin concentrations at the transect locations as a function of flow rate is presented on Figures 5.4-38. The data points presented in this figure are averages of all data points collected at a particular transect for each measured flow event.

Figure 5.4-39 presents a scatter plot of all aldrin surface water data. Note the symbols and colors indicate the sample type—point vs. transect—and the general flow conditions of the sampling event—low flow, storm water-influenced, or high flow).

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Discrepancies
1. The database has 4 WO13 entries, 3 listed at RM 6.7, one at 6.9E. Two of those listed at 6.7 are given as SP-NB-1 XAD and SP-NB-2 XAD, one as SP-NB-2 Peristaltic, and the one at 6.9E as Peristaltic SP-NB-1. Map 5.3-1a lists/plots WO13 at 6.9E, but as XAD SP. For this evaluation the 4 entries are treated as distinct (although they could be pairwise replicates).

5.4.10.1 Aldrin Data

Aldrin was measured by EPA method 8081A in 84 of the total 180 peristaltic sample events; 59 SP-NB, 16 SP-NS, 8 SB-VI, 0T-NB, and 1 T-NS samples. High-volume surface water samples (XAD samples) were analyzed by HRGC/HRMS in93 of the total 121 XAD samples collected; 26 SP-NB, 11 SP-NS, 12 T-NB, 12 T-NS, and 32 T-VI samples.

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Here, for both counts, "sample" may include replicates –a sample event may involve taking sample + replicate, and replicates have been averaged for the sample count. The sample event count is from the (old) Table 5.4-1.

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With one exception, Aldrin was not detected in any of the peristaltic samples, with detection limits ranging from 0.000057 to 0.0058 µg/L; all but 3 of these detection limits were less than 0.001 µg/L. The single detect was a SP-NB measurement of 0.0052 µg/L at W030 (RM 5.5E) during high flow. This was 319 times the highest detect in the XAD data (discussed below), and the non-detect SP-NS sample at the same location and time had the (higher) detection level of 0.0058 µg/L. For comparison, the ODEQ water quality criterion for human health is 0.000005 µg/L,

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Aldrin concentrations, calculated as the sum of the dissolved (XAD column) and particulate (XAD filter) concentrations, were detected in 81 of the 93 samples, with detection limits in the non-detects ranging from 0.000000613 to 0.0000062 µg/L.

5.4.10.2 Aldrin Relationship to River Flow Conditions

Detected aldrin concentrations in samples collected during low-flow conditions ranged as follows (the station listed is for the maximum):

- SP-NB: 0.00000031 J µg/L to 0.0000163 J µg/L (station W015 at RM 6.9W)
- SP-NS: Not sampled
- SP-VI: Not sampled
- T-NB: 0.00000439 J µg/L to 0.00000662 J µg/L (station W005 at RM 3.9)
- T-NS: 0.000001791 J µg/L to 0.0000046 J µg/L (station W027 at Multnomah Channel)
- T-VI: 0.000000296 J µg/L to 0.00000409 J µg/L (station W025E at RM 2)

Detected aldrin concentrations in samples collected during storm water-influenced flow conditions ranged as follows (the station listed is for the maximum):

- SP-NB: 0.00000141 J µg/L to 0.00000367 J µg/L (station W033 at RM 7.0W)

- SP-NS: 0.000000635 J µg/L to 0.00000484 J µg/L (station W033 at RM 7.0W)
- SP-VI: Not sampled
- T-NB: 0.00000201 J µg/L to 0.00000575 J µg/L (station W027 at Multnomah Channel)
- T-NS: 0.00000204 J µg/L to 0.00000263 J µg/L (station W027 at Multnomah Channel)
- T-VI: 0.0000011 J µg/L to 0.00000326 J µg/L (station W025 W at RM 2)

Detected aldrin concentrations in samples collected during high flow conditions ranged as follows (the station listed is for the maximum):

- SP-NB: 0.000000514 J µg/L to 0.00000407 J µg/L (station W033 at RM 7.0W)
- SP-NS: 0.00000216 J µg/L to 0.00000352 J µg/L (station W035 at RM 8.5 in Swan Island Lagoon)
- SP-VI: Not sampled
- T-NB: 0.00000281J µg/L to 0.00000475 J µg/L (station W027 at Multnomah Channel)
- T-NS: 0.00000257 J µg/L to 0.000004 J µg/L (station W005 at RM 3.9)
- T-VI: 0.00000124 J µg/L to 0.00000599 J µg/L (station W025 M at RM 2)

Aldrin concentrations were slightly lower in the low flow than in the high flow XAD samples. Comparison with stormwater influenced samples is difficult due to the high frequency of non-detects.

Concentration trends along the river were examined by using T-VI XAD samples, either single samples (November 2004, March 2005, July 2005, January 2006, January 2007, March 2007) or averages of East, West, and Middle samples (September 2006, November 2006). Low flow samples are consistent in showing a decreasing concentration trend between RM 6 and 1 in the three events with suitable samples (November 2004, March 2005, July 2005), consistent with no sources in this range. The high flow event of January 2006 and the storm water event of November 2006 indicate an increasing concentration between RM 3 and RM 1. One low flow event (September 2006) and one high flow event (January 2007) showed an increase in

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concentration between RM 11 and RM 2, suggesting sources within that range, while a second high flow event (March 2007) showed a decrease in concentration.

5.4.10.2 Spatial Distribution of Aldrin

Five detected XAD samples exceeded the ODEQ criterion for human health (water + organisms) of 0.000005 µg/L:

- W011 (RM 6.3 T-NB)
- W027 (Multnomah Channel T-NB)
- W025 (RM 2M T-VI)
- W005 (RM 3.9 T-NB)
- W015 (RM 6.9W SP-NB)

The highest XAD concentration measurement of 0.0000163 µg/L was in a SP-NB measurement at W015 (RM 6.9W) but the nearest available measurements in W032 and W033 and downriver in W011 do not suggest an area of elevated concentrations.

5.4.11 Dieldrin in Surface Water

Dieldrin data are summarized in Tables 5.4-6 through 5.4-11. Transect samples are summarized by flow event in Tables 5.4-6, 5.4-8, and 5.4-11. Single-point samples are summarized by flow event in Tables 5.4-7a-d, 5.4-9a-d, and 5.4-11a-d. All dieldrin surface water sample results are presented in Table 5.4-20 by sample event and sample ID number.

Dieldrin concentrations in surface water XAD columns and filters and dieldrin concentrations from the peristaltic pumps are presented in stacked bar graphs by flow event and by river mile/channel position on Figures 5.4-40 and 5.4-41.

Dieldrin concentrations at the transect locations as a function of flow rate is presented on Figure 5.4-42. The data points presented in this figure are averages of all data points collected at a particular transect for each measured flow event.

Figure 5.4-43 presents a scatter plot of all dieldrin surface water data. Note the symbols and colors indicate the sample type—point vs. transect—and the general flow conditions of the sampling event—low flow, storm water-influenced, or high flow).

5.4.11.1 Dieldrin Data

Dieldrin was measured by EPA method 8081A in 84 of the total 180 peristaltic sample events; 59 SP-NB, 16 SP-NS, 8 SB-VI, 0T-NB, and 1 T-NS samples. High-volume surface water samples (XAD samples) were analyzed by HRGC/HRMS in 93 of the total 121 XAD samples collected; 26 SP-NB, 11 SP-NS, 12 T-NB, 12 T-NS, and 32 T-VI samples.

The range of detected concentrations in the 3 SP-NB peristaltic samples in which dieldrin was detected was 0.0010 to 0.0012 µg/L (maximum value during high flow at both W036, RM 8.6, February 2007 and W028, RM 3.6E, March 2007).

Dieldrin concentrations, calculated as the sum of the XAD column and XAD filter concentrations, ranged from 0.0000167 to 0.000384 µg/L. The range of dieldrin concentrations measured under all flow conditions, by XAD sample type, are presented below.

- SP-NB: 0.0000227 to 0.00019 J µg/L (High Flow, station W033 at RM 7.0W)
- SP-NS: 0.0000319 J to 0.00018 J µg/L(High Flow, station W033 at RM 7.0W)T-NB: 0.0000306 J to 0.0001577 µg/L (High Flow, station W005 at RM 3.9)
- T-NS: 0.00000322 J to 0.0001593 J µg/L (High Flow, station W005 at RM 3.9)
- T-VI: 0.00001673 J to 0.0003837 J µg/L (High Flow, station W005 at RM 3.9)

5.4.11.2 Dieldrin Relationships to River Flow Conditions

Where detected, dieldrin concentrations were relatively consistent in both low flow and high flow samples, and were also relatively similar across sample types. The range of dieldrin concentrations by sample type are presented below.

Dieldrin concentrations in samples collected during low flow conditions ranged as follows:

- SP-NB: 0.0000227 to 0.0000625 µg/L (W015 at RM 6.9W)
- SP-NS: Not Sampled
- SP-VI: Not Sampled.
- T-NB: 0.00003481 J to 0.00004866 J µg/L (W005 at RM 3.5, September 2006)
- T-NS: 0.0000353 J to 0.00004703 J µg/L (W005 at RM 3.5, September 2006)

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- T-VI: 0.00001673 J to 0.00004615 J µg/L (W023 W at RM 11, September 2006)

Dieldrin concentrations in samples collected during high flow conditions ranged as follows:

- SP-NB: 0.0001096 J to 0.00019 J µg/L (station W033 at RM 7.0W, February 2007)
- SP-NS: 0.0001085 J to 0.00018J µg/L (station W033 at RM 7.0W, February 2007)
- SP-VI: Not Sampled
- T-NB: 0.000099 to 0.0001577 µg/L (W027 at Multnomah Channel , February 2007)
- T-NS: 0.000071 to 0.0001593 J µg/L (W005 at RM 3.9, March 2007)
- T-VI: 0.000085 to 0.000384 µg/L (W005 at RM 3.9, January 2006)

Dieldrin concentrations in samples collected during stormwater influenced conditions ranged as follows:

- SP-NB: 0.00003617 J to 0.00005005 J µg/L (W031 at RM 6.1W, November 2006)
- SP-NS: 0.0000319 J to 0.0000498 J µg/L (W031 at RM 6.1, November 2006)
- SP-VI: Not Sampled.
- T-NB: 0.0000306 J to 0.00004815 J µg/L (W024 at RM 16, November 2006)
- T-NS: 0.0000322 J to 0.00005367 J µg/L (W024 at RM 16, November 2006)
- T-VI: 0.0000251 J to 0.0000387 J µg/L (W023 E at RM 11, November 2006)

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5.4.11.3 Spatial Distribution of Dieldrin

All of the surface water samples analyzed for dieldrin exceeded the human health ODEQ value developed to be protective of drinking water and consumption of organisms (5.3×10^{-6} µg/L). No sample result exceeded the ODEQ dieldrin chronic value for protection of aquatic life (0.056 µg/L).

5.4.12 Arsenic in Surface Water

Arsenic data are summarized in Tables 5.4-6 through 5.4-11. Transect samples are summarized by flow event in Tables 5.4-6, 5.4-8, and 5.4-10. Single-point samples are summarized by flow event in Tables 5.4-7a-d, 5.4-9a-d, and 5.5-11a-d. All total and dissolved arsenic surface water sample results are presented in Tables 5.4-21a-b by sample event and sample ID number. Dissolved and particulate arsenic concentrations in surface water collected from peristaltic pumps are presented in stacked bar graphs by flow event on Figures 5.4-44 and by river mile/channel position on Figure 5.4-45.

Arsenic concentrations at the transect locations as a function of flow rate are presented on Figure 5.4-46. The data points presented in this figure are averages of all data points collected at a particular transect for each measured flow event.

Figure 5.4-47 presents a scatter plot of all arsenic surface water data. Note the symbols and colors indicate the sample type—point vs. transect—and the general flow conditions of the sampling event—low flow, storm water-influenced, or high flow).

5.4.12.1 Arsenic Data

Peristaltic samples were collected and analyzed by EPA Method 6020 for total and dissolved arsenic during Rounds 2A and 3A. Arsenic was detected in 136 (78 percent) of the 174 dissolved samples and 157 (90 percent) of 174 total samples during the Round 2A and 3A sampling events.

Total arsenic concentrations were generally consistent across the entire Study Area during the Round 2A and 3A sampling events. The overall range of detected concentrations for all total arsenic samples was narrow, ranging from 0.25 to 0.75 µg/L suggesting that there are no specific areas with elevated arsenic concentrations.

5.4.12.2 Arsenic Relationship to River Flow Conditions

Detected arsenic concentrations were relatively consistent regardless of flow rate; however, frequency of detection was significantly reduced during storm water-influenced events. The frequency of detection was 100% for total arsenic and 98% for dissolved arsenic for all combined low flow and high flow sampling event sample results. The frequency of detection was 58% for total arsenic and 13% for dissolved arsenic for the storm water-influenced samples.

While total arsenic concentrations were relatively consistent, in general, they were slightly higher in low flow sampling events with concentrations ranging from 0.33 to 0.75 µg/L compared to high flow sampling events with concentrations ranging from 0.25 to 0.63 µg/L. Thirty-nine storm water-influenced samples displayed a narrow range of detected concentrations between 0.43 to 0.53 µg/L. Dissolved and particulate arsenic concentrations in surface water are depicted in histograms by flow event type on Figure 5.4-44 for high flow, low flow and storm water-influenced events.

Arsenic concentrations in samples collected during low flow conditions ranged as follows:

- Total arsenic, Single Point: 0.33 µg/L to 0.75 µg/L at station W001 (RM 2.0E in July 2005).
- Dissolved arsenic, single-point: 0.25 µg/L to 0.64 µg/L at station W001 (RM 2.0E in July 2005).
- Total arsenic, Transect: 0.35 to 0.64 µg/L (station W025 E at RM 2.0 in September 2006).
- Dissolved arsenic, Transect: 0.19 to 0.60 µg/L (station W025 M at RM 2.0 in September 2006).

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Arsenic concentrations in samples collected during high flow conditions ranged as follows:

- Total arsenic, Single point: om 0.30 µg/L to 0.63 J µg/L at in February 2007 station W034 (NS; RM 7.5).
- Dissolved arsenic, Single Point: 0.19 J µg/L to 0.34 J µg/L in February 2007 at station W034 (NS; RM 7.5).
- Total arsenic, Transect: 0.25 to 0.54 µg/L at station W005 (RM 4) and station W023 (RM 6.3), in January 2006.
- Dissolved arsenic, Transect: 0.18 to 0.28 µg/L at station W027 (NB; Multnomah Channel) in February 2007.

Arsenic concentrations in samples collected during stormwater influenced conditions ranged as follows

- Total arsenic, Single Point 0.43 J µg/L to 0.53 J µg/L at station W038 (NB; RM 11).
- Dissolved arsenic, Single Point: 0.38 J µg/L to 0.48 µg/L at station W038 (NB; RM 11E).
- Total arsenic, Transect: 0.44 to 0.48 J µg/L at station W005 (NB; RM 4).
- Dissolved arsenic, Transect: Not detected.

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5.4.12.3 Spatial Distribution of Arsenic

All of the total and dissolved arsenic surface water results were less than the drinking water MCL of 10 µg/L and the ODEQ human health criteria of 2.1 µg/L and the ODEQ chronic value of 150 µg/L for the protection of aquatic life. .

5.4.13 Chromium in Surface Water

Data for chromium in surface water are summarized in Tables 5.4-6 through 5.4-11. Transect samples are summarized by flow event in Tables 5.4-6, 5.4-8, and 5.4-10. Single-point samples are summarized by flow event in Tables 5.4-7a-d, 5.4-9a-d, and 5.4-11a-d. All total and dissolved chromium surface water sample results are presented in Tables 5.4-22a-b by sample event and sample ID number.

Dissolved and particulate chromium concentrations in surface water collected from peristaltic pumps are presented in stacked bar graphs by flow event on Figures 5.4-48 and by river mile/channel position on Figure 5.4-49. Figure 5.4-50 is a line plot of transect chromium concentrations in surface water by river mile (RM 2-16). The data points presented in this figure are averages of all data points collected at a particular transect for each measured flow event. Finally, Figure 5.4-51 is a scatter plot of chromium concentrations in surface water by river mile (RM 2-16). The symbols and colors indicate the sample type—point vs. transect—and the general flow conditions of the sampling event—low flow, storm water-influenced, or high flow).

5.4.13.1 Chromium Data

Peristaltic samples were collected and analyzed by EPA Method 6020 for total and dissolved chromium during Rounds 2A and 3A. Chromium was detected in 58 of 174 (33 percent) of dissolved samples and 112 of 174 (64 percent) of total samples during the Round 2A and 3A sampling events.

Total chromium concentrations were generally consistent across the entire Study Area during the Round 2A and 3A sampling events. The overall range of detected concentrations for all total chromium samples was 0.2 to 1.92 µg/L. The range of detected concentrations of dissolved chromium was narrower, ranging from 0.1 to 0.83 µg/L.

5.4.13.2 Chromium Relationship to River Flow Conditions

In general, total chromium concentrations were slightly lower in samples collected during low flow sampling events with concentrations ranging from 0.2 to 1.09 µg/L compared to results from high flow sampling events where total chromium concentrations ranged from 0.58 to 1.92 µg/L. Dissolved chromium concentrations were generally lower in low flow samples. Detected dissolved chromium concentrations ranged from 0.43 to 0.83 µg/L in high flow samples and from 0.1 to 0.33 µg/L in low flow samples.

Thirty-nine storm water-influenced samples were analyzed for total and dissolved chromium. Neither total chromium nor dissolved chromium was detected in any of those samples.

Chromium concentrations in samples collected during low flow conditions ranged as follows:

- Total Chromium, Single Point: 0.2 µg/L to 0.91 µg/L at station W004 (RM 3.7E) in March 2005.
- Dissolved Chromium, Single Point: 0.1 µg/L to 0.33 µg/L at station W004 (RM 3.7E) in March 2005.
- Total Chromium, Transect: 0.29 to 1.09 µg/L at station W005 (RM 3.9) in September 2006.
- Dissolved Chromium, Transect: 0.12 to 0.29 µg/L at station W011 (RM 6.3) in July 2005.

Chromium concentrations in samples collected during high flow conditions ranged as follows:

- Total chromium, Single Point: 0.7 µg/L to 1.92 J µg/L at station W031 (RM 6.1W).
- Dissolved Chromium, Single Point: 0.43 to 0.64 µg/LW034 (RM 7.5W) in February 2007.
- Total Chromium, Transect: 0.58 to 1.73 µg/L at station W027 (Multnomah Channel)) in February 2007.
-
- Dissolved Chromium, Transect: 0.46 to 0.83 µg/L at station W024 (RM 16) in January 2007.

Neither total nor dissolved chromium was detected in any single-point or transect samples collected during the November 2006 storm water-influenced sampling event.

5.4.13.3 Spatial Distribution of Chromium

All of the total and dissolved chromium surface water results were less than the drinking water MCL of 100 µg/L. ODEQ does not have a human health or aquatic life criteria for total chromium.

5.4.14 Copper in Surface Water

Copper data are summarized in Tables 5.4-6 through 5.4-11. Transect samples are summarized by flow event in Tables 5.4-6, 5.4-8, and 5.4-10. Single-point samples are summarized by flow event in Tables 5.4-7a-d, 5.9a-d, and 5.4-11a-d. All total and dissolved copper surface water sample results are presented in Tables 5.4-23a-b by sample event and sample ID number.

Dissolved and particulate copper concentrations in surface water collected from peristaltic pumps are presented in stacked bar graphs by flow event on Figures 5.4-52 and by river mile/channel position on Figure 5.4-53. Figure 5.4-54 is a line plot of transect copper concentrations in surface water by river mile (RM 2-16). The data points presented in this figure are averages of all data points collected at a particular transect for each measured flow event. Finally, Figure 5.4-55 is a scatter plot of copper concentrations in surface water by river mile (RM 2-16). The symbols and colors indicate the sample type—point vs. transect—and the general flow conditions of the sampling event—low flow, storm water-influenced, or high flow).

5.4.14.1 Copper Data

Peristaltic samples were collected and analyzed by EPA Method 6020 for total and dissolved copper during Rounds 2A and 3A. Copper was detected in 99 percent of 174 dissolved samples and 100 percent of 174 total samples during the Round 2A and 3A sampling events.

Total copper concentrations were generally consistent across the entire Study Area during the Round 2A and 3A sampling events. The overall range of detected concentrations for all total copper samples ranged from 0.65 to 3.68 µg/L.

5.4.14.2 Copper Relationship to River Flow Conditions

Total copper concentrations were generally consistent across the entire Study Area during the Round 2A and 3A sampling events. Concentrations were generally higher in samples collected during the high flow sampling events, with concentrations ranging from 1.1 to 3.68 µg/L compared to samples collected during low flow sampling events, with concentrations ranging from 0.68 to 2.09 µg/L. Forty storm water-influenced samples displayed a narrow range of detections between 0.65 to 1.14 µg/L. Dissolved and particulate copper concentrations in surface water are depicted in histograms by flow event type on Figures 5.4-52 for high flow, low flow and storm water-influenced events.

Copper concentrations in samples collected during low flow conditions ranged as follows:

- Total copper, Single Point: 0.68 µg/L to 2.09 µg/L at station W004 (RM 3.7) in March 2005.
- Dissolved copper, Single Point: 0.37 to 1.64 µg/L at station W022 (NB; RM 9.7W) in July 2005.
- Total copper, Transect: 0.68 µg/L to 1.55 µg/L at station W005 (NB; RM 3.9) in September 2006.
- Dissolved copper, Transect: 0.45 µg/L to 0.83 J µg/L at station W011 (RM 6.3) in July 2005.

Commented [Integral36]: Previous sections only presented detected data.

Commented [KK37R36]: See response above.

Copper concentrations in samples collected during high flow conditions ranged as follows:

- Total copper, Single Point: 1.47 µg/L to 3.49 µg/L at station W031 (NB; RM 6.1W) in February 2007..
- Dissolved copper, Single Point 0.55 µg/L to 1.22 µg/L at station W035 (NS; RM 8.5E) in February 2007.
- Total copper, Transect: 1.1 µg/L to 3.68 J µg/L at station W023 (RM 11) in January 2006.
- Dissolved copper, Transect: 0.43 µg/L to 2.39 J µg/L at station W023 (RM 11) in January 2006.

Copper concentrations in samples collected during stormwater influenced conditions in November 2006 ranged as follows

- Total copper, Single Point: 0.79 to 1.14 µg/L at station W035 (NS; RM 8.5E).
- Dissolved copper, Single Point: 0.50 to 0.78 µg/L at station W035 (NS; RM 8.5E).
- Total copper, Transect: 0.65 µg/L to 1.1 µg/L at station W024 (RM 16).
- Dissolved copper, Transect: 0.46 µg/L to 1.23 µg/L at station W023 M (RM 11).

5.4.14.3 Spatial Distribution of Copper

All of the total and dissolved copper surface water results were less than the drinking water MCL of 1,300 µg/L and the ODEQ human health threshold value of 1,300 µg/L developed to be protective of drinking water and consumption of organisms.

These results do not suggest potential source areas for copper.

5.4.15 Zinc in Surface Water

Data for zinc in surface water are summarized in Tables 5.4-6 through 5.4-11. Transect samples are summarized by flow event in Tables 5.4-6, 5.4-8, and 5.4-10. Single-point samples are summarized by flow event in Tables 5.4-7a-d, 5.4-9a-d, and 5.4-11a-d. All total and dissolved zinc surface water sample results are presented in Tables 5.4-24a-b by sample event and sample ID number.

Dissolved and particulate zinc concentrations in surface water collected from peristaltic pumps are presented in stacked bar graphs by flow event on Figures 5.4-56 and by river mile/channel position on Figures 5.4-57. Figure 5.4-58 is a line plot of transect zinc concentrations in surface water by river mile (RM 2-16). Finally, Figure 5.4-59 is a scatter plot of zinc concentrations in surface water by river mile (RM 2-16).

5.4.15.1 Zinc Data

Peristaltic samples were collected and analyzed by EPA Method 6020 for total and dissolved zinc during Rounds 2A and 3A. Zinc was detected in 73 of 174 (42 percent of dissolved samples and 133 of 174 (76 percent) of total samples during the Round 2A and 3A sampling events.

Detected total zinc concentrations in all surface water samples during the Round 2A and 3A sampling events ranged from 1.65 to 57.9 µg/L. The range of detected concentrations of dissolved zinc in all Round 2A and 3A samples was 0.9 to 41.9 µg/L.

5.4.15.2 Zinc Relationship to River Flow Conditions

With the exception of one sample (station W022 on 12/2/2004) with elevated total (57.9 µg/L) and dissolved (41.9 µg/L) zinc concentrations, detected zinc concentrations were within a narrow range regardless of flow. With the exclusion of the one total result, detected concentrations of total zinc in low flow samples ranged from 1.65 to 8.8 µg/L at station W004 (RM 3.7E) in March 2005. Comparable to low flow, in high flow samples total zinc concentrations ranged from 1.85 to 8.4 µg/L. In contrast, total zinc was not detected during stormwater influenced sampling.

With the exception of the one dissolved result for W022 on 12/2/2004, detected dissolved zinc concentrations ranged from 0.9 to 4.9 µg/L at station W018 (RM 8.3) in November 2004 in low flow samples. Dissolved zinc was only detected in one high flow sample at 2.5 µg/L at station W005 in January 2006. In stormwater influenced samples dissolved zinc was detected in five of 39 samples (4.8 to 6.6 µg/L, station W034, NB.).

Zinc concentrations in samples collected during low flow conditions ranged as follows

- Total zinc, Single Point: 1.65 µg/L to 57.9 µg/L at station W022 (RM 9.7W) in November 2004.
- Dissolved zinc, Single Point: 0.9 µg/L to 41.9 µg/L at station W022 (RM 9.7W) in November 2004.
- Total Zinc, Transect from 2.1 to 6.1 µg/L at station W023 W (RM 11) in September 2006.
- Dissolved Zinc, Transect: 1.4 to 2.2 µg/L at station W023 (RM 11) in November 2004.

Zinc concentrations in samples collected during high flow conditions ranged as follows:

- Total zinc, Single Point: 3 to 8.4 µg/L at station W031 (NB, RM 6.1W).
- Dissolved Zinc, Single Point: Not detected.

- Total Zinc, Transect: 1.85 to 6.38 µg/L at stations W024 (RM 16) and W023 (RM 11) in January 2006.
- Dissolved Zinc, Transect: detected in only one sample; 2.5 µg/L at station W005 (RM 3.9) in January 2006

Zinc concentrations in samples collected during stormwater influenced conditions in November 2006 ranged as follows:

- Total zinc, Single Point: Not detected.
- Dissolved zinc, Single Point: 4.8 to 6.6 µg/L at station W034 (NS, RM 7.5W).
- Total Zinc, Transect: Not detected.
- Dissolved zinc, Transect: was detected in a single transect storm water-influenced sample at 5.1 µg/L at station W025 M (RM 2).

5.4.15.3 Spatial Distribution of Zinc

All of the total and dissolved concentrations of zinc in surface water were substantially below the ODEQ human health value of 2,100 µg/L developed to be protective of drinking water and consumption of organisms. An MCL has not been established for zinc.

5.4.16 TBT Ion in Surface Water

Data for TBT in surface water are summarized in Tables 5.4-6 through 5.4-211 Transect samples are summarized by flow event in Tables 5.4-6, 5.4-8, and 5.4-10. Single-point samples are summarized by flow event in Tables 5.4-7a-d, 5.4-9a-d, and 5.4-11a-d. All TBT surface water data are presented in Table 5.4-25 by sample event and sample ID number.

TBT concentrations in surface water collected from peristaltic pumps are presented in stacked bar graphs by flow event and by river mile/channel position on Figures 5.4-60 and Figure 5.4-61, respectively. Figure 5.4-62 is a line plot of transect TBT concentrations in surface water by river mile (RM 2-16). Finally, Figure 5.4-63 is a scatter plot of TBT concentrations in surface water by river mile (RM 2-16).

5.4.16.1 TBT Data

Peristaltic samples of surface water were collected and analyzed by the Krone Method (Krone et al, 1989) for TBT during Rounds 2A and 3A. TBT was detected in a 12 of 174 (7 percent) of all surface water samples collected during the Round 2A and 3A sampling events. Detected TBT concentrations in all surface water samples collected during the Round 2A and 3A sampling events ranged from 0.00095 to 0.011 µg/L.

5.4.16.2 TBT Relationship to River Flow Conditions

The small number of TBT detections in surface water samples was associated with a narrow range of detected concentrations regardless of flow. Detected concentrations of TBT in low flow samples ranged from 0.00095 to 0.0023 µg/L. During high flow sampling events TBT was detected twice at the same station, W035 RM 8.5 E, 0.0021 µg/L (NS) and 0.0035 µg/L (NB).

Thirty-seven storm water-influenced samples were analyzed for TBT. TBT was detected in only four of these samples at concentrations ranging from 0.0010 to 0.011 µg/L.

TBT concentrations in samples collected during low flow conditions ranged as follows

- Single Point: 0.00095 µg/L to 0.0023 µg/L at station W004 (NB, RM 3.7E) in March 2005.
- Transect: Not detected.

TBT concentrations in samples collected during high flow conditions ranged as follows

- Single Point: 0.0021 to 0.0035 µg/L at station W035 (RM 8.5) in February 2007.
- Transect: Not detected.

TBT concentrations in samples collected during stormwater influenced conditions ranged as follows

- Single Point: 0.0013 to 0.0014 µg/L at W035, (NS, RM 8.5 E).
- Transect: 0.0001 to 0.011 µg/L at W024 (NB, RM 16) in November 2006.

5.4.16.3 Spatial Distribution of TBT

5.4.17 There is neither an ODEQ human health or an aquatic life criteria for TBT ion. **Site-Specific Evaluation of Hydrophobic Contaminants**

For the purposes of this evaluation and presentation, hydrophobic contaminants are defined as those contaminants or groups of contaminants that are insoluble or minimally soluble in water, and are therefore expected to bind strongly to sediments and suspended particulates. The subset of hydrophobic contaminants included in this evaluation are PCBs, dioxins and furans, DDT and related compounds (DDx), and PAHs.

5.4.17.1 Distribution Between PCB Dissolved and Particulate Fractions

The following subsections describe observed trends in dissolved and particulate total PCB congener concentration fractions by river mile, event type, and sample type of in the Round 2A and 3A data set. The spatial distribution of dissolved and particulate PCB concentrations and relationships to flow rate, TSS, and f_{oc} are described. PCB congeners were detected in all XAD filter and column samples collected during Round 2A and 3A sampling events.

5.4.17.1.1 PCB Particulate and Dissolved Concentrations

Total PCB concentrations as a function of flow rate are presented in Figure 5.3-64. Figures 5.3-65 and 5.3-66 show the dissolved and particulate fractions of total PCBs plotted against flow rate. All of the particulate and dissolved samples with concentrations >1,000 pg/L were collected during low-flow conditions, which includes a single dissolved sample collected during the stormwater-influenced sampling event. For the particulate fraction, low-flow single point samples span a greater concentration range (up to almost 0.01 ug/L) as compared to the remaining samples which are typically less than 0.001 ug/L. For the dissolved fraction of total PCBs, low-flow and stormwater-influenced samples cover similar concentration ranges, while high-flow exhibit generally lower concentrations. Low flow point samples collected at the upper end of the dissolved concentration range (>0.0005 µg/L) tended to have a higher particulate component of the total concentration.

The high flow samples (both point and transect) tend to exhibit lower dissolved concentrations relative to the storm water-influenced flow and low flow samples. This suggests a different character/source of PCB contaminated sediment and/or suspended solids concentration and character during high flow events.

The transect sample collected at RM 11 during the low flow event in November 2004 exhibited a high particulate to dissolved concentration ratio. As noted previously, during collection of this sample, the field crews observed runoff from a nearby storm drain, which may have contributed to this result.

Total PCB concentrations as a function of TSS are presented on Figures 5.4-67. High flow samples (single-point and transect) exhibited the widest range and highest concentrations of TSS, from approximately 10 to 60 mg/L, but the lowest PCB concentrations. Conversely, the remaining samples exhibited a greater range in concentration over a small range in TSS—low flow TSS concentrations were less than 10 mg/L and stormwater influenced concentrations from approximately 0 to 20 mg/L TSS. The high flow samples also exhibited a lower dissolved/particulate concentration ratio relative to the storm water-influenced and low flow samples.

Particulate total PCB concentrations and POC concentrations are compared on Figures 5.4-68a-b. The high flow samples (single-point and transect) exhibited lower PCB concentrations for the corresponding POC, than other flow regimes.. The low POC values are consistent with the lower f_{oc} associated with TSS observed in high flow samples, as shown on Figure 5.4-69. This observation suggests the introduction of suspended particles with low organic carbon content during high flow events. Further, the solids that become suspended in the water column during high flow events may have a different character (low f_{oc} and low PCB concentrations) than those introduced during low flow or storm water-influenced events.

5.4.17.2 Distribution Between PCDD/F Dissolved and Particulate Fractions

The following subsections describe the observed trending in dissolved and particulate total PCDD/Fs fractions by river mile, event type, sample type, TSS, and f_{oc} of the TSS. This analysis was specific to total PCDD/Fs and ,therefore, does not extend to individual dioxins and furans.

5.4.17.2.1 PCDD/F Dissolved and Particulate Concentrations

The dissolved and particulate fractions of total PCDD/F concentrations for each surface water sample are presented as histograms by flow event type on Figure 5.4-14 and by channel position on Figure 5.4-15. As expected for hydrophobic compounds, PCDD/Fs tend to partition to the particulate fraction in surface water within the Study Area. The two highest concentrations measured at RM 6.7 and 11 during low flow and storm water-influenced conditions, respectively, exhibit high particulate to dissolved ratios (greater than an order of magnitude difference between the two phases). This partitioning is consistent for all the samples.

5.4.17.2.2 PCDD/F Associations with Suspended Solids

Total concentrations as a function of TSS are presented on Figure 5.4-69. PCDD/F concentrations in high flow transect samples appear to exhibit a slightly increasing PCDD/F concentration trend with higher suspended solids. Concentrations in low flow and storm water-influenced samples appear to vary independently of suspended solids concentration. The transect and single point samples collected during low flow and stormwater influenced events were all characterized by TSS values less than those of the high flow event.. (Figures 5.4-70).

Particulate total PCDD/F concentrations and POC concentrations are compared on Figure 5.4-70. Relative to other flow regimes, POC was relatively low in high flow samples (single point and transect). Thee the storm water-influenced samples tended to exhibit marginally higher POC. Solids that become suspended during storm water-influenced events may have a unique character of high f_{oc} and varying loads of PCDD/Fs. Samples characterized by higher concentrations of PCDD/Fs did not have corresponding high TSS concentrations. However, these high PCDD/F concentration samples did exhibit a high particulate-phase PCDD/F concentration as a function of POC.

5.4.17.3 Distribution Between DDx Dissolved and Particulate Fractions

The following subsections describe the observed trends in total DDx dissolved and particulate fractions by river mile, event type, sample type, TSS, and f_{oc} of the TSS.

5.4.17.3.1 DDx Particulate and Dissolved Concentrations

The distribution of total DDx by river mile is presented on histograms by flow event type on Figures 5.4-20 and histograms by channel position on Figures 5.4-21. Three samples collected at RM 2 (station W025) during low-flow conditions exhibited higher dissolved to particulate ratios. This may be due to the lower suspended solids load in the downstream portion of the Study Area (at RM 2) rather than an actual shift in partitioning behavior. However, these higher dissolved:particulate ratios are not exclusive to these samples.

Total DDx concentrations as a function of flow rate are presented in Figures 5.4-71a-b. With the exception of the highest total DDx concentrations that were measured at RM 6.9 and 7.2, a relationship between flow rate and total DDx concentrations is not evident during low-flow conditions (Figure 5.3-71a). Considering the uncertainty associated with the discharge measurements noted in section 5.4-2, the similarity in concentration for flow events is not suprising. However, it is apparent when in Figure 5.3-71b that there is a general increase in concentration with flow.

5.4.17.3.2 DDx Associations with Suspended Solids

Total concentrations as a function of TSS are presented on Figures 5.4-72a-b. The highest ratios of DDx to TSS were exhibited in low flow samples while high flow samples exhibited a much lower ratio of total DDx concentration to TSS. The low flow and storm water-influenced samples had low suspended solids loads (25 J mg/L or lower) compared to high flow samples (up to 62 mg/L). When the single-point samples with elevated DDx concentrations are excluded, DDx concentrations tend to increase with TSS.

Particulate total DDx concentrations and POC concentrations are compared on Figures 5.4-73a-b. With the exception of low-flow point samples, DDx concentrations appear independent of POC. High flow samples exhibited higher TSS concentrations and lower f_{oc} on TSS percentages. Therefore, the higher concentrations in the surface water during high flow events (Figures 5.4-72a-b) were present in spite of lower POC in the water column. Again, this may suggest a different source or sources of particles, upstream of the Study Area, given the high inflow concentrations at RM 16 and 11 during high flow events. Higher POC concentrations were found in transect and single-point storm water-influenced and low flow samples with lower total particulate DDx concentrations.

5.4.17.4 Distribution Between PAH Dissolved and Particulate Fractions

The following subsections describe the observed trends in the dissolved and total PAH fractions by river mile, event type, sample type, TSS, and f_{oc} of the TSS.

5.4.17.4.1 PAH Particulate and Dissolved Concentrations

The spatial distribution of dissolved and particulate total PAH concentrations is presented on histograms for each surface water sample by flow event type and river mile on Figure 5.4-81a; Figure 5.4-81b presents the same data with a reduced y-axis scale to better show lower concentrations. Figures 5.4-82a-b through 5.4-83a-b present the same data arranged by channel position.

Total PAH concentrations as a function of flow rate are presented in Figure 5.4-75. Four of the five highest concentrations of total PAHs were measured in single-point samples collected during low-flow conditions. Total PAH concentrations tended to vary independently of flow condition. However, samples with elevated PAHs concentrations were moreevident in low-flow samples from RM 7 to 2 compared to the high-flow and stormwater-influenced sampling events. Downstream near RM 2, the low-flow sample concentrations were generally lower those observed further upstream within the Study Area.

While a general trend of greater partitioning in the dissolved phased is evident, a notable exception was observed at station W035 at RM 8.5 during the January 2007 high flow event. Both the NB and NS samples exhibited a greater particulate to dissolved concentration ratio. Also, at stations W011 (RM 6.3) and W005 (RM 4) the NB samples had noticeably higher particulate total PAH concentrations in the low flow and storm water-influenced sampling events. In the January 2007 high flow sampling event, this pattern was reversed at station W035 (RM 8.5), and the NS sample had the highest particulate total PAH concentration.

5.4.17.4.2 PAH Associations with Suspended Solids

Total PAH concentrations as a function of TSS are presented on Figures 5.4-76. High flow samples (single-point and transect) exhibited the widest range and highest concentrations of TSS but generally lower total PAH concentrations. However, there does appear to be a trend of gradually increasing total PAH concentrations with higher TSS values for the high flow samples. Low flow and storm water-influenced samples tended to exhibit low TSS but a wider range of PAH concentrations.

Particulate total PAH concentrations and POC concentrations are compared on Figure 5.4-77. The high flow samples (single-point and transect) exhibited relatively low total PAH concentrations and POC. The low POC values are consistent with the lower observed f_{oc} of the suspended solids during this flow condition. Several high flow samples exhibited POC values equal to zero (Figure 5.4-77) because the calculated POC was considered to be zero if the DOC was greater than the TOC. These low POC values indicate that the high flow events are associated with low f_{oc} sediments.